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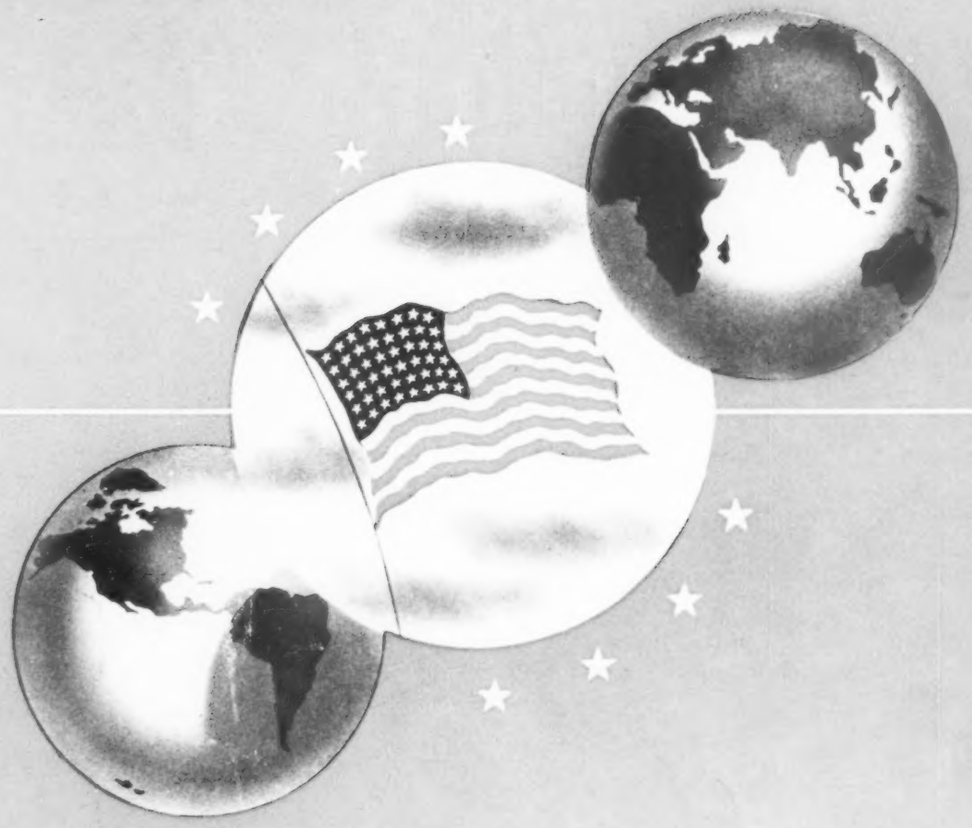

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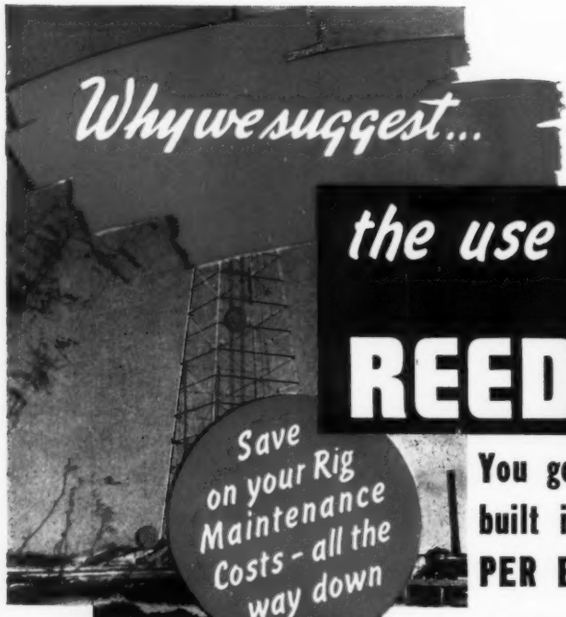

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Incorporating Petroleum Equipment Exporter

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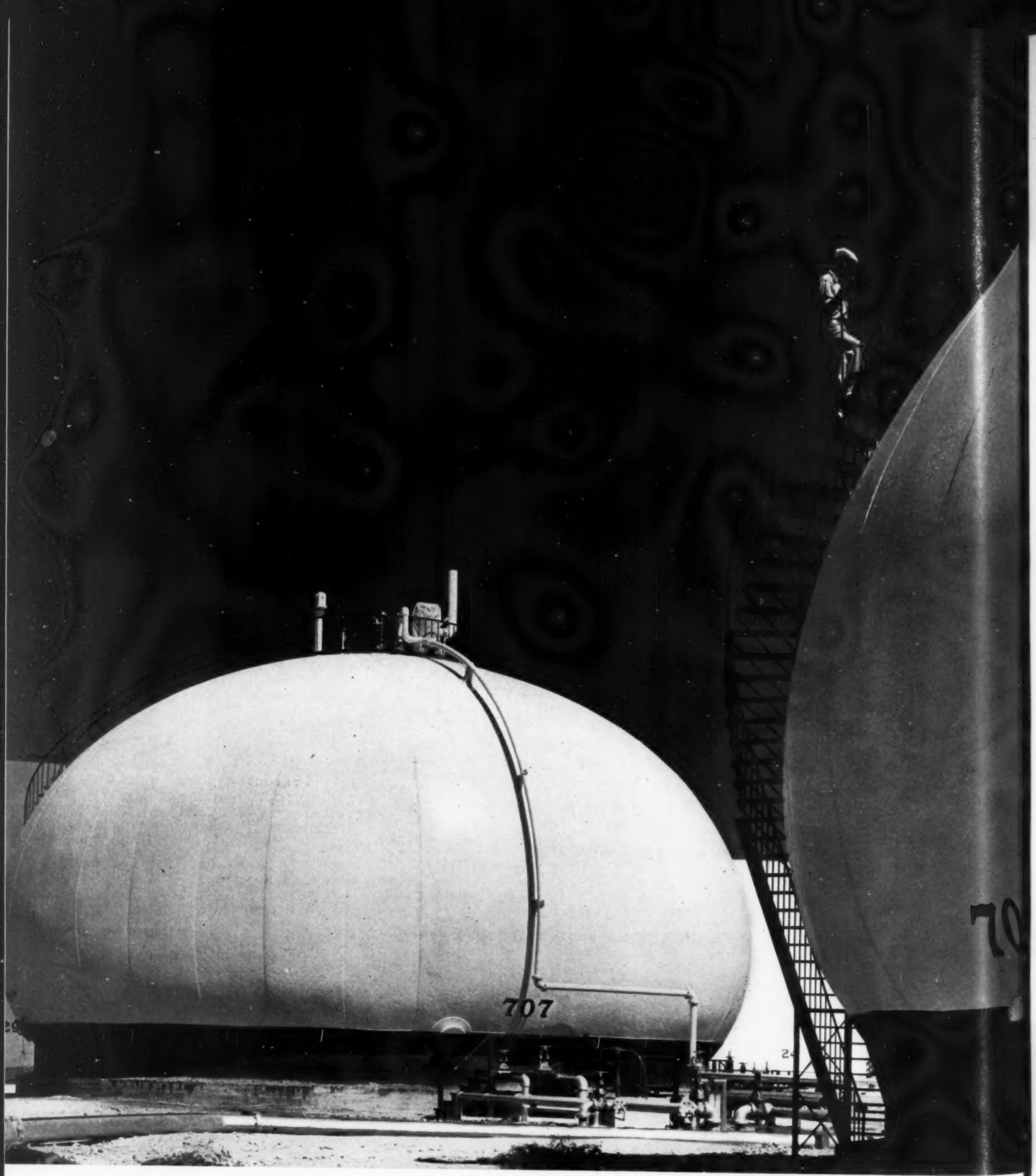


Photograph by Robert Yarnall Richa

EDITORIAL

OIL INDUSTRY ALONE CAN REPLACE LOST RUBBER SUPPLY

IN THE transition of a democratic nation to a war footing a certain amount of muddling about appears inevitable. Fortunately for the United States this period of indecision, time wasting and false starts in the effort to set up an effective organization for war production had been nearly passed when the country was plunged into actual conflict. Needful government control over essential materials and their distribution had been largely though not fully centralized. The job of converting these materials into a swiftly ascending volume of products required for a worldwide military struggle had been assigned to men of practical experience and proved ability drawn from the ranks of industrial management

In the six months since Japan's treacherous descent on Pearl Harbor a story of unparalleled achievement has been written in time schedules exceeded, construction records shattered and an outturn total that surpasses all estimates. Though forced to refit many of their plants and to handle machines and materials new to them American workers and American business executives have accomplished results that assure certain victory in the battle of production.

Against this background of efficiency the great rubber enigma presents a conspicuous example of how not to do it. That the problem has not been dealt with expeditiously and effectively is admitted. Yet, as happens in most cases of official fumbling, it is difficult to pin responsibility on any one department or branch of the government. The axiom that everybody's job is nobody's concern clearly applies. As pointed out by the Truman Committee the federal agencies having to do with rubber included the War Production Board, the Reconstruction Finance Corporation and its subsidiaries, the Office of Petroleum Coordinator, the Office of Defense Transportation, the Board of Economic Warfare, the Department of Agriculture, and the Office of Price Administration. But until recently clear responsibility for dealing with the situation was not placed squarely on any of these.

Even after the Japanese conquest of Malaya and Netherlands India had emphasized the necessity of replacing with all possible speed the imports of natural rubber thereby cut off, the needed expansion of the synthetic rubber program was allowed to drift. Divided jurisdiction and divergent views among official agencies remained. Conflicting statements as to actual war requirements, as to the possibility of replacements from scrap rubber within the country and as to the readiest means of averting a threatened shortage increased the confusion of the public. Worst of all politics, successfully barred for the most part from other war production activities, intruded itself upon the rubber controversy and politicians seized upon the great popular interest in the subject to promote pet schemes or satisfy animosities.

In retrospect it is easy to criticize government agencies for not accumulating a larger stockpile of crude rubber in the period following July 1940 when funds and authorization for such purchases were voted by Congress. It is equally simple to point out that restrictions should have been placed upon commercial consumption at that time. Apparently, however, nobody in official circles, and certainly very few outside, anticipated the summary severance of supplies that took place within a few weeks after Japan's first treacherous attack. As a matter of fact the reserve acquired by the United States government, though not sufficient to satisfy all military and industrial demands, is the only substantial accumulation of natural rubber in existence at the present time. One of the complications in the rubber problem as it stands arises from the fact that others of the United Nations were even less forehanded in providing against a potential scarcity. As a result America must share its own inadequate supply with these other participants in the common cause.

One of the depressing features in the widespread discussion is the persistent effort on the part of a few men whose official positions give them an audience to place responsibility for the lack of a fully developed synthetic rubber industry in the United States upon the shoulders of the large rubber and oil companies. The attempt to stir up class strife and popular prejudice reveals its political animus by the repetition of discredited charges after the facts have been placed on record. It is an indefensible abuse of official position which not only hampers the development of a highly important part of the war program but creates additional misunderstanding on a subject already enveloped in confusion.

Facts clearly established in reference to this subject are that while a certain amount of experimentation looking

to the development of a suitable substitute for natural rubber was carried on in the United States beginning as much as twenty-five or thirty years ago the first really encouraging lead toward the successful working out of the problem came as a result of research and investigation carried on in Germany. The right to make use of this information was acquired by Standard Oil Company (New Jersey) as a possible future means of providing a commercial outlet for petroleum. The information thus obtained, broadened and developed by further research, enabled the company to produce a general purpose synthetic rubber and its own experimentation led to the development of a second type particularly adapted to certain specialized requirements. Meanwhile other experimenters arrived at a similar result by other routes. Practically all the large rubber companies as well as some few oil companies spent large sums on research in this field and methods of producing acceptable rubber substitutes were worked out to the point where they could be applied in full plant operation.

None of these companies, however, entered upon the manufacture of synthetic rubber except on a very limited scale, mostly in the field of high priced products. The reason is a very simple one; synthetic rubber could not be made at a cost permitting it to compete with the natural product. No private manufacturer could afford to invest millions of dollars in a plant that was certain to lose money on its operations. The claim that such commercial operation was deliberately discouraged in order to prevent the building up of an American industry is ridiculous. Actually negotiations were undertaken by Standard Oil with leading rubber manufacturers looking to the application and development of its processes and other companies did the same but lack of a profit incentive stayed progress in this direction.

Another political attack that has been pursued most industriously is that of professional friends of the farmer like Senator Gillette of Iowa who maintain that the erection of small alcohol plants in rural communities throughout the country would quickly supply the raw material to satisfy the nation's full requirements in the matter of rubber. Then there are the experts with secret processes which they are willing to make available for a reasonable consideration and those who contend that by collecting rabbit brush from the western plains or planting kolsagyz or guayule or some other available shrub the threat of rubber shortage can be banished.

It is well known to scientists that numerous plants will yield small quantities of substances of rubber-like characteristics but they also know—what proponents of these plans omit to mention—that none of these have recommended themselves as commercially feasible and that in any case serious technical problems remain to be solved before they can be utilized, regardless of the question of cost. It is an established fact that alcohol can be made to produce a type of synthetic rubber. The Standard Oil Company has conducted numerous experiments along this line the results of which they have offered to the Department of Agriculture for free use of all who wish to follow up the subject. But it is likewise true that in experiments in this field by other companies it has been found more advantageous to obtain alcohol for this purpose from petroleum rather than from grain or other agricultural products.

Actually the one certain and dependable source from which it is possible to obtain butadiene in quantity sufficient to meet national needs is petroleum. The one industry that has the necessary background of research, technical skill and practical knowledge to make good the loss of natural rubber is the oil industry working in conjunction with the rubber industry, the former to supply the raw material and the latter to manufacture the finished product. The processes have been proved, the know-how exists, the materials can be supplied to produce a million tons yearly, or more if need be. The only thing lacking is sufficient plant capacity for such large scale production. This lack cannot be supplied at once. Time is required for the erection of plants and for bringing them into successful operation. In pursuing this line of endeavor, however, we are at least on solid ground and working for results which we know can be attained. It was recognition of this situation that led the official agencies responsible for the success of the synthetic rubber program to entrust the greater part of it to petroleum refining and rubber manufacturing companies.

From a purely selfish viewpoint the primary interest of the oil industry is to have a plentiful supply of rubber restored at the earliest possible date. When tires are abundant enough to bring motor transportation back to its normal dimensions oil producers will recover a market that is a thousand times more important to them than anything they can possibly gain from the business of making butadiene which may last only as long as the war itself. If a usable substitute for natural rubber can be produced from cornstalks, milk weed, dandelions or golden rod more quickly and cheaply than from petroleum the members of the oil industry will welcome the result. They know however that synthetic rubber products are being made successfully by oil refiners today and that the increase of production to any desired volume is simply a matter of adding plant capacity without uncertainty or risk as to the outcome.

It is entirely fitting to explore all possible sources of synthetic rubber and to appropriate money for the study of the potentialities of farm crops and available plants and shrubs. For early and sure supplies of this sorely needed product, however, the country must rely upon the petroleum industry as it has in the case of so many other essential war materials.

Tank Cars, Pipelines Promise East Coast

RELIEF IN 1943

Railroads Expected to Transport 900,000 Bbl. per Day to District 1 —Over 1,000,000 Bbl. Per Day With Nation-Wide Rationing. Texas-Indiana Line to be Completed by December 1.

WASHINGTON, JUNE 25

OFFICIAL approval finally has been extended to pipe line construction which, with the stimulation of tank car and barge deliveries, is expected to moderate a fuel oil shortage that might have serious consequences on home heating and industrial activity in the eastern states during the coming winter. The large diameter pipe line from Longview, Texas, to Mount Vernon, Indiana, with its connections for which steel has been released by the WPB will help the situation but such relief as it can afford will not be effective before the end of 1942 or well into the coming heating season of 1942-43.

Meanwhile, the railroads of the country, aided by the cooperation of the oil companies in providing loading and discharge facilities and stepping up turn arounds at terminals are filling the gap in eastern supplies caused by the withdrawal of tankers. The movement of petroleum into District 1 by rail has been multiplied tenfold within the past nine months and reached an all-time peak of 731,250 bbl. daily for the week ended June 13. It is estimated that tank car shipments can be brought up to 900,000 bbl. daily before the end of the summer. As indicated in the article on Page 24 a spokesman for the Association of American Railroads believes that the daily movement can be increased to 1,000,000 bbl. if nation-wide rationing releases an additional 15,000 cars. One limiting factor in the extension of use of rail tank cars is the necessity for transporting other liquid war essentials such as industrial alcohol, liquefied chlorine, and vegetable oil. Vegetable oil alone will require 73,000 tank car loads in 1942 compared with 57,000 tank car loads in 1941 according to an ODC survey quoted by J. B. Eastman.

Approximately 83 percent of the 143,140 tank cars in all types of service are used in transporting petroleum; 9,004 are railroad-owned, leaving 109,802 privately owned tank cars available for the transportation of oil in all parts of the country. In April, 1941 a mere 11,250 bbl. per day was moved into the Atlantic States by tank car; after the warnings issued by Petroleum Coordinator Ickes during last summer, the figure increased to 77,014 bbl. per day by mid-September, 1941. At that time there was some discussion as to whether the railroads could move as much as 250,000 bbl. per day into District 1, but with the growing realization of the seriousness of the submarine menace to coastwise shipping, railroad movement East reached 525,697 bbl. per day by the first week in April, 1942. From that date until June 13 there was a steady increase with the exception of the weeks ended May 30 and June 6 when floods in Pennsylvania reduced deliveries. In addition to an increase in cars loaded, from 47,077 for the week ended September 20, 1941 to 56,000 cars loaded for the week ended June 13, 1942 switching and short haul service has been drastically reduced from the estimated 30 percent of equipment so used in 1941 and in preceding years.

The program of the Car Service Division of the Association of American Railroads under the direction of W. E. Callahan includes rules to speed up tank car movement which result in solid trains of tank cars being moved on main tracks through yards and terminals and the handling of these cars in blocks instead of individually. By concentrating oil movement to eastern points on one good route to each point, rather than dividing tonnage over three or four routes, it is possible to handle more train loads. New tracks and facilities are being constructed and Sunday and holiday switching, loading and unloading have been inaugurated. Oil companies have been encouraged to substitute tank truck for rail handling of short haul movements and every effort has been made to avoid more than 24 hour lay-overs for unloading. By careful supervision and checking at gateways, terminals, shipping and receiving points much of the program for speeding up deliveries of oil by tank car has been made effective. Privately owned tank cars have shown an increase in miles per day from 45.3 in January 1941 to 54.1 in January 1942, to 90.3 in March 1942, and finally to approximately 100 miles per day in April 1942.

Within 48 hours of approval by WPB of the 24-in. 550 mile pipeline from Longview, Texas, to Mount Vernon, Ind. orders for the pipe had been placed with National Tube Company and construction is expected to start by July 15; it is hoped that the line may be completed by December 1 or possibly even earlier.

The line will be financed by the RFC and while final organization plans have not as yet been worked out, it has been decided that the line will be built and operated as a common carrier by the petroleum industry. It will be available to any shipper of crude oil under rules and regulations contained in tariffs to be filed with the Interstate Commerce Commission. The pipe will be delivered in double random lengths of approximately 40 ft. each, the first 140 miles to be delivered during July. In August an additional 170 miles will be laid down; in September 130 miles, and in October 110 miles, will be delivered to complete the 550 miles of pipe ordered. The pipe will be 24 in. diameter, seamless, with a wall thickness of three-eights inch to meet API specifications 5-L, grade B. The entire line will be welded and ten pumping stations will be located at 55 mile intervals. Surveys were made by the oil companies last year so that construction can be begun as soon as pipe and pumps are available. The entire construction job including the right of way will cost approximately $35,000,000 to $40,000,000.

The line will carry 300,000 bbl. per day of East Texas crude to the Indiana river terminal at Mount Vernon. From this point the oil will be moved by short pipelines to rail connections in Bridgeport, Stoy and Martinsville, Illinois and to Lima, Ohio where loading racks are available for transhipment by rail to eastern refinery centers. About 150,000 bbl. per day can be handled in this way. Another 100,000 bbl. per day will be delivered via the Ohio River, to Pittsburgh and thence to the East Coast by pipeline and tank car. Approximately 20,000 bbl. per day will be piped through existing lines to Chicago and some of this oil will be moved to Buffalo by lake tankers.

Petroleum Coordinator Ickes' original proposal to the War Production Board called for a through line from Texas to New York. Only the first leg has so far been authorized but there is a possibility that a connection eastward to the New York and Philadelphia refining centers may be authorized by WPB before the end of the year. A committee headed by Wayne Johnson has been instructed by Donald Nelson to continue studies as to the availability of steel for the eastern leg of the big pipeline.

CONSTRUCTIVE SERVICE is being rendered by the Axelson Manufacturing Company through a series of timely advertisements in petroleum publications designed to promote proper maintenance of equipment and to prolong production in the face of shortages of critical materials. The first advertisement in the campaign deals with prolonging the service life of sucker rods. The second series of ads explains where adequate substitutions for various types of steel can be made; the third stresses the necessity for frequent inspection of oil well pumps.

Adjusting Inland Transport To Meet

WAR EMERGENCY

Full Use of Available Facilities Plus

Careful Conservation will Assure East

Coast Supplies For Balance of Year

NO SUBJECT is of more direct personal interest to the great American public at the moment than that of gasoline rationing and its possible extension from the Atlantic Seaboard to the rest of the country. Nor is there any other subject as to which more confusion of thought exists, both as to the purpose to be served, and as to the extent to which restrictions are made necessary by war conditions. Because public cooperation is essential to the success of rationing plans and because the public will gladly endure any privation if satisfied that it will contribute to the success of the war effort it is worth while to survey the whole situation in order to ascertain the facts and their bearing upon the immediate future of motor transportation. Such an examination of facts serves a useful purpose by allaying needless alarm on the one hand and on the other preventing unjustified optimism that might defeat the primary purpose of the conservation effort.

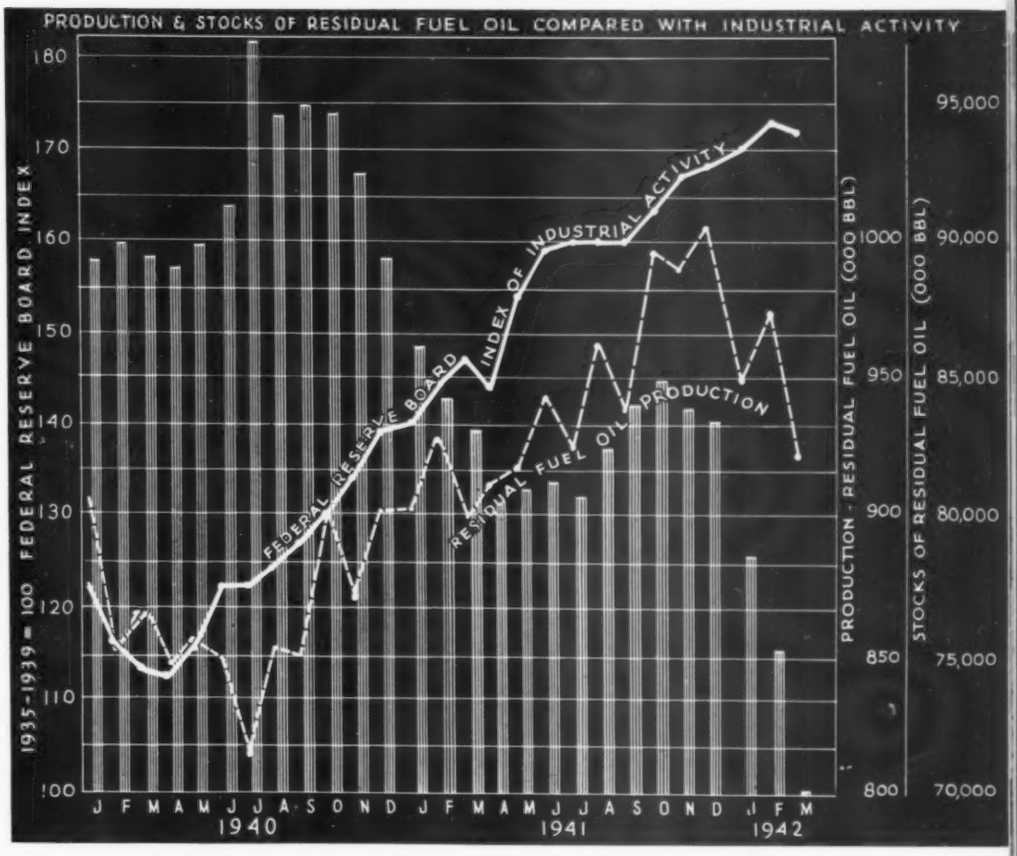
Photograph by Robert Yarnall Richie

Part of the misapprehension regarding rationing results from a failure to define clearly the purpose which it is designed to attain. In the seventeen eastern states the placing of restrictions on the use of motor fuel has been due to the suspension of customary transportation service. The extent and duration of the limitation imposed depends upon the degree to which other methods of moving petroleum products can be developed. Throughout the central and western states the proposal for reduction in the use of motor vehicles is prompted by the necessity to save rubber pending the time when synthetic production reaches the point where it will be ample both for war needs and civilian demands. The two projects interlock to the extent that gasoline rationing in the East necessarily will entail a saving of rubber and rubber rationing in the West may make it easier to meet petroleum requirements in the eastern area. Both factors must be taken into account in a sound appraisal of the situation and necessary remedial measures.

Close examination of both subjects indicates that the states along the Atlantic can be supplied with gasoline and fuel oil until the end of the year when additional pipe line capacity will become available but that this can be accomplished only by strict economy and limitation to essential uses. The period for which existing rubber supplies can be made to render service depends likewise upon the care with which they are employed and the restrictions placed upon avoidable use. The solution of both problems depends upon an understanding of their real dimensions and a willingness to make the adjustments they call for.

In considering the supply situation of the Atlantic Seaboard section of the United States several indeterminate factors affect the computation of essential requirements. Consumption of distillate in domestic heating depends upon winter temperatures which are subject to wide variations. Demand for residual fuel oil has been pushed up by expanding industrial activity. Conversion of oil heating equipment to coal has been urged upon both classes of users but the possibilities in this direction are limited and may easily be overbalanced by the other factors mentioned.

On the side of supply the quantity of petroleum products that can be made available to the eastern states depends to some extent upon the restrictions placed upon the use of automobiles in other parts of the country. In the East this is being regulated by the rationing of gasoline. In the interior where motor fuel is plentiful its application will be dictated by the need of conserving rubber. Limitations there may be less severe and may be influenced by the results of the nation-wide campaign of scrap rubber collection just concluded. Necessity of making present supplies last until 1944 indicates a practical certainty, however, that non-essential use of rubber will be eliminated so far as possible throughout the country and consequent reduction in motor fuel consumption in the Midwest may permit some acceleration of the eastward movement of crude and products. Taking into account all known factors a survey of the situation indicates that supplies for the eastern area comprising Petroleum Coordinator's District No. 1 will just about balance essential demand to the end of the year with the reduction of stocks to an operating minimum. Construction of the large capacity pipe line from Texas to Illinois will not affect conditions for the remainder of the year since it will not be completed until December but it may be expected to ease the situation somewhat by the beginning of 1943. Substantial relief from this source will require extension of the line to the Atlantic Coast which is now under consideration.



Production and stocks of residual fuel oil in relation to industrial activity suggests trend of consumption for coming year.

By the maximum use of all facilities available for transportation of petroleum into District 1, including additional rail tank cars that may be released as a result of nation-wide tire rationing, this area can command 1,384,000 bbl. per day. Drastic restrictions on all non-essential use of automobiles, the conversion of a maximum number of domestic heating units and factory power generating systems to coal can bring essential requirements down to 1,504,548 bbl. per day, in view of increased industrial activity in the manufacturing areas along the Atlantic Coast. The deficiency of 120,548 bbl. per day will reduce present East Coast stocks to the minimum necessary to keep the oil industry functioning.

In analyzing requirements for transportation of petroleum and products into Petroleum Coordinator's District 1 comprising the entire eastern seaboard from Maine to Florida and including West Virginia and Pennsylvania, it is assumed that universal rubber conservation will be adopted in some form. With full normal use the reservoir of tires presently in use on automobiles, supplemented by the 8,000,000 tires now frozen in dealer's hands, would be exhausted by mid-April, 1943. By strict economy in rubber it will be possible to maintain required mobility until March, 1944 by keeping some 20 million passenger cars in use until that date. This period could be extended somewhat by the use of tires made from an indeterminate quantity of scrap rubber which the government is now attempting to collect. Thereafter, it is anticipated that the output of synthetic rubber, supplemented by small supplies from natural sources, will be available in sufficient quantity to relieve the situation. Such nation-wide rationing, motivated in the greater part of the country solely by the need for rubber conservation, would have two important effects on transportation requirements into District 1: It would make available a larger number of railroad tank cars for use in relieving the East Coast shortage and it would insure the reduction in East Coast consumption that has been attempted through rationing in this area since May 15.

Work on pipelines all over the country is designed to increase the flow of oil eastward by this and other available inland transportation means.

In estimating the petroleum transportation requirements for District 1 a first step is to determine the minimum amount of petroleum products necessary to avoid disruption of the war effort. In the case of gasoline, this means the elimination of all but essential passenger car operation; but it should be borne in mind that some passenger car transportation is essential for agricultural and industrial efficiency. Allowance must also be made for increased use of buses and trucks which naturally accompanies the increased tempo of manufacturing operations and increased need for mass transportation of workers. Since gasoline represents 40 percent of the anticipated demand for petroleum products in District 1, this is, of course, the most important single product; moreover it presents the greatest field for saving in petroleum requirements. It is also necessary to estimate the demand for kerosene and range oil, for gas oil and distillate, and for residual fuel oil. Some savings are possible in consumption of distillate fuel oil used for domestic heating. Industrial fuel oil also can be conserved by conversion to coal where possible, but against this saving must be set the increased demand arising from the accelerated rate of industrial activity. Finally, in view of the minimum requirements, available means of oil transportation must be analyzed with consideration of the possibilities of increasing quantities carried by these means. For the present at least, transportation of petroleum and products to the Eastern Seaboard by tanker must be discounted 100 percent and it must be assumed that District 1 will have to rely on other means of supplying essential requirements for an indefinite time.

In considering the necessity for nation-wide rationing to conserve rubber, it should be borne in mind that there are approximately 27 million passenger automobiles operating in the United States. Under normal circumstances these cars would travel an average of 9,000 miles per year, or a total of 243,000 million vehicle-miles. There are 126 million tires now on the wheels or spare racks of these cars and an additional eight million new tires frozen in the hands of dealers. The potential vehicle-miles represented by this reservoir of tires may be reckoned as follows: 39 million three year old tires capable of delivering 28,080 million vehicle-miles; 42 million two year old tires capable of delivering 94,080 million vehicle-miles; 45 million one year old tires capable of delivering 162,000 million vehicle-miles; and eight million new tires capable of delivering 34,560 million vehicle-miles. Altogether this represents a potential of 318,720 million vehicle-miles, assuming that the government develops a pooling method so that when any car is left with less than four tires the remaining tires will immediately be made available for other cars; in other words, assuming that all tires are available for use at all times. With normal use running to 243,000 million vehicle-miles per year and a potential reservoir of 318,720 million vehicle-miles left in existing tires as of January 1, 1942, it is apparent that the reservoir would last until mid-April, 1943.

Of the 27 million cars mentioned above, two million are dispensable; these represent the extra cars in multiple car ownership families, or passenger cars owned by farm families who also own trucks. As a result of strict rationing these two million cars would be removed from the roads, representing a reduction in mileage of 18,000 million vehicle-miles. Of the remaining 25 million passenger automobiles, five million could be reduced from an average of 9,000 miles per year to 2,000 miles per year. This could be accomplished by giving a minimum basic ration of gasoline to cars of which full use is not essential. As pointed out by Charles L. Dearing in his booklet, "Automobile Transportation in the War Effort," published by the Brookings Institute: "In effect, the rationing of a basic minimum of gasoline to some five million owners would have to be viewed primarily as a means of compensating these owners for acting as storage or custodial agents for the government. It would permit them to make very limited use of some 25 million tires pending the determination of need for requisitioning them in the public interest." Mr. Dearing suggests that it would be necessary for the government to retain the owners of these five million cars as custodial agents because of the administrative and storage difficulties that would confront any government agency charged with the requisitioning

and maintenance of these cars. The basic ration necessary to reduce the annual average mileage from 9,000 to 2,000 in the case of five million non-essential automobiles would be about what it now is for motorists holding A cards in District 1—three gallons per week. The saving represented by this reduction in mileage would be of the order of 35,000 million vehicle-miles.

There would then be 20 million passenger cars which may be considered essential to maintain mobility required for efficient functioning of industrial and agricultural production necessary to the war effort. These are divided about as follows: 10 million passenger cars essential to maintain necessary mobility in rural areas and in urban areas not served by mass transportation systems; 4.4 million cars needed to supplement the mass transportation systems in small (25,000-50,000) cities; 3.4 million automobiles necessary to supplement mass transportation systems in medium (50,000-500,000) cities; and two million cars needed to supplement mass transport in large (over 500,000) cities. It may be seen then that 20 million passenger automobiles are the minimum necessary for effective operation of industry and agriculture. But the mileage in the case of these vehicles could be reduced by not less than 30 percent. Such a reduction would involve abandonment of all recreational driving doubling up in the case of workers travelling to and from their jobs and other economies; but a 30 percent reduction in mileage for 20 million essential cars would effect a saving of 45,000 million vehicle-miles per year.

By elimination of two million cars, drastic restriction in use of five million non-essential cars and reduction of 30 percent in use of 20 million essential cars, a total saving of 98,000 million vehicle-miles per year would be possible. Essential use would aggregate only 145,000 million vehicle-miles in contrast to the normal 243,000 million vehicle-miles. Applied to the existing potential of 318,720 million vehicle-miles remaining in available tires, essential mobility could be maintained to the middle of March 1944. This additional year would greatly increase the probability of relief through progress in the development of the synthetic rubber program, or through partial restoration of supplies from natural sources in South America and elsewhere.

Total gasoline consumption in District 1 during 1941 amounted to 646,300 bbl. per day. The 9,813,000 passenger cars in this area consumed about 486,313 bbl. per day; the 1,538,000 trucks in the East consumed about 152,433 bbl. per day; the estimated 51,000 buses in the same area consumed approximately 7,554 bbl. per day. It has been estimated that without rationing there would be a five percent increase in passenger car demand, a 25 percent increase in truck demand and a 17 percent increase in bus demand in 1942. This would represent an increase in gasoline demand for District 1 of 63,700 bbl. per day or total demand of 710,000 bbl. per day average for the year. The significance of the breakdown between passenger cars, buses and trucks lies, of course, in the fact that truck and bus consumption would have to receive the additional gasoline estimated above; and the entire saving would have to come from the less essential use of passenger automobiles category.

The application of rationing to District 1, coupled with a prohibition against the operation of more than one car by a family unit, would secure a substantial reduction in gasoline consumption. In the first place some 726,899 cars would be eliminated entirely, this being the estimated number of surplus passenger automobiles in multiple car ownership families, or passenger cars belonging to farm families who also operate a truck. The elimination of these 726,899 cars would effect a saving of 37,816 bbl. per day in District 1. Of the remaining 9,086,248 cars that would be kept in service, 5,150,897 represent passenger cars in rural areas. It has been estimated by Dearing that a 30 percent reduction in use should be possible for cars in this classification. This would involve the elimination of all recreational and social driving and presuppose doubling up and economizing in every possible direction. A 30 percent reduction in rural use would, however, effect a saving of 86,009 bbl. per day in District 1. Dearing has further analyzed reports of the American Transit Association to determine the capacity of mass transportation systems in cities of various sizes to absorb additional loads. On the basis of his conclusions, it should be possible to reduce passenger car use in cities of 25,000 to 50,000 by 20 percent. In District 1 this would save 8,575 bbl. per day. In cities of 50,000 to 500,000 a saving of 25 percent in use of passenger cars would be possible; the gasoline saving in District 1 for cars registered in these medium cities would be 24,126 bbl. per day. Finally, a 50 percent saving is possible in large cities with populations over 500,000 since these metropolitan areas are well equipped with mass transportation systems. Such a saving in large cities on the Eastern Seaboard would amount to 51,585 bbl. per day. Altogether, savings in use of gasoline in District 1 would aggregate 208,111 bbl. per day reducing the quantity of gasoline that it would be necessary to transport into this area for use in passenger automobiles to 302,518 bbl. per day. To this would have to be added the anticipated increased consumption by trucks and buses. While trucks are estimated to have consumed 152,433 bbl. per day in 1941, it may be assumed that this consumption would increase to 190,541 bbl. per day during 1942. Buses consumed approximately 7,554 bbl. per day in 1941 and will probably consume not less than 8,830 bbl. per day during the present year. Total gasoline consumption in view of the increased use of buses and trucks and drastic curtailment of passenger automobiles would then be about 501,890 bbl. per day.

Insignificant savings are possible in the case of kerosene and range oil. Since these products are used mainly for cooking, lighting and to a very limited extent for heating, the only possible saving would be through conversion of equipment for cooking and heating to gas or coal burning appliances. In general kerosene and range oil are consumed by low income groups; the cost of conversion of equipment would constitute a severely limiting factor on the extent of reduction in consumption of these products. In the normal course of events an increase of four percent in consumption of kerosene and range oil would be expected in District 1: This would bring the demand from 118,600 bbl. per day for 1941 to 123,344 bbl. per day during 1942. At most, conversions of equipment to coal and increased efficiency in the use of equipment could hardly be expected to reduce the consumption more than six percent from the anticipated figure, leaving a minimum essential demand for these products in District 1 of 115,944 bbl. per day. Perhaps the most important petroleum product

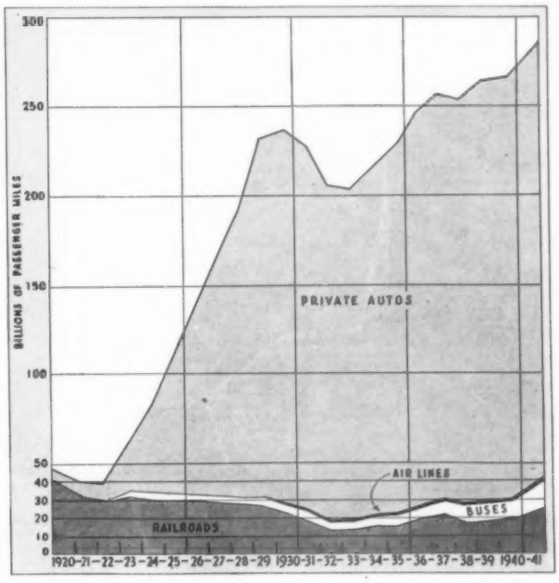
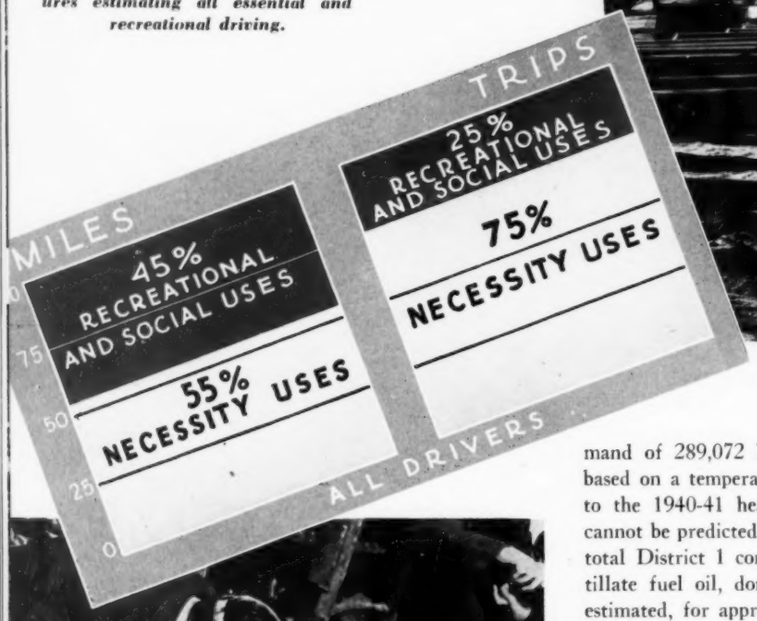


Chart prepared by the Pullman Company showing trend in normal distribution of transportation.

for use in District 1 for the immediate future is gas oil and distillate fuel oil. Due to the remarkable growth in the use of distillate fuel oil for domestic heating this product under normal circumstances might soon rival gasoline in volume of demand; its importance to civilian life already exceeds that of gasoline in many respects. Possibilities of reducing consumption are limited, and may be non-existent, since domestic fuel oil consumption is a direct function of temperature and cannot be predicted in advance. Agencies of the petroleum industry working with interested government officials have estimated consumption of distillate fuel oil and gas oil for all purposes in District 1 as 258,100 bbl. per day throughout 1941: For 1942 it is estimated that there would be a normal increase of 12 percent or total demand of 289,072 bbl. per day. This figure is based on a temperature range exactly equivalent to the 1940-41 heating season, a variable that cannot be predicted with any accuracy at all. Of total District 1 consumption of gas oil and distillate fuel oil, domestic heating accounts, it is estimated, for approximately 82 percent or some 237,039 bbl. per day throughout the year.

Right: Movement of coastwise tankers which formerly brought over 90 percent of petroleum products from the Gulf Coast to District 1 has now been suspended.

Below: Automobile facts and figures estimating all essential and recreational driving.



Detailed examination of the recorded range of temperature in New York City alone during the heating season of 1940-41 and the sixty year average for this locality has been figured in degree-days. It should be noted that domestic heating oil consumption varies directly with the number of degree-days in any period. The degree-day is the average of the maximum and minimum daily temperature subtracted from 65 and multiplied by the number of days in the period for which the degree-days are being figured. It has been found in practice that consumption of fuel oil for domestic heating is a direct function of the number of degree-days in a heating season. The average for the past 60 years for New York City shows 5,348 degree-days: in the 1940-41 heating season there were 4,701 degree-days or 12 percent below normal. These calculations, based on the foregoing temperature statistics for New York City are given as examples only; there are, of course, wide variations between the New York record and that of other localities in District 1. It is also important to note that these records have no bearing on possible consumption of heating oil in the coming heating season, which might well be 12 percent above normal. Hence it is impossible to estimate in advance any percentage saving in domestic fuel oil consumption. A reduction in inside temperature of three to four degrees for all oil-heated homes would achieve a saving of 10 percent in fuel oil consumption: but an increase in degree-days for the coming heating season of only 470 degree-days over last year would entirely nullify such saving and yet the average for the heating season, even with the addition of 470 degree-days, would still be 3.31 percent below normal.

The one direction in which substantial savings in the use of fuel oil for domestic heating can be accomplished with certainty is conversion of oil burning equipment to coal. While estimates as high as 450,000 burners suitable for conversion have been proposed, a careful study by *Fuel Oil and Oil Heat* indicates that there are approxi-

mately 273,000 furnaces capable of being converted to coal at a cost of between $50 and $100 each. This represents those furnaces that have been converted from coal to oil and could be reconverted with a minimum of new equipment and at a reasonable cost. If it should be possible to accomplish this conversion program to the extent of 273,000 burners, there would be a saving of 18 percent in fuel consumption for domestic heating. If the degree-days for the entire District 1 did not exceed normal (which would still be approximately 10 percent above last winter for the entire area) total requirements for domestic heating oil in District 1 would be 190,901 bbl. per day. There would remain some 52,063 bbl. per day required for Diesel fuel and other uses. Consequently the total gas oil and distillate fuel oil requirements for District 1 would amount to 242,964 bbl. per day under the best possible circumstances. Substantial stocks would be required to avoid a serious situation should the winter season prove substantially colder than the normal as might well prove to be the case.

In regard to residual fuel oil, no reduction in consumption will be possible for District 1: on the contrary there probably will be a marked increase in demand for this product due to increased industrial activity. An accompanying chart reveals the steep upward trend of the seasonally adjusted index of industrial activity for the entire country compiled by the Federal Reserve Board. This curve indicates an increase of 25 percent in the twelve months ended March 1942 as compared with the twelve months ended March, 1941 and it is hardly to be doubted that industrial activity will continue to increase for the twelve months ending March, 1943. Since the consumption of residual fuel oil in District 1 amounted to 422,000 bbl. per day in 1941, it has been estimated, after making due allowance for conversion of some industrial burners from oil to coal, that consumption during 1942 will amount to 474,750 bbl. per day minimum for this area. Demand for all other petroleum products if restricted as much as possible, will still amount to about 169,000 bbl. per day for the year.

Including rationed demand for gasoline, restricted demand for range oil and kerosene, for distillate fuel oil and gas oil and for residual fuel oil and miscellaneous petroleum products, minimum consumption of 1,504,548 bbl. of petroleum products per day in District 1 appears to be a reasonable estimate of requirements for the remainder of the year.

Against this essential demand a total present supply to District 1 of only 1,053,000 bbl. per day is now available. This figure, however, can be substantially increased by maximum use of facilities now employed, and will be relieved further by the first of the year as a result of the pipeline from Longview, Texas to Mount Vernon, Ind., and to a minor degree by other pipeline projects under way, recently authorized by the War Production Board. Between now and the end of the year however deficiencies in present transport facilities will have to be compensated for mainly by withdrawals from stocks.

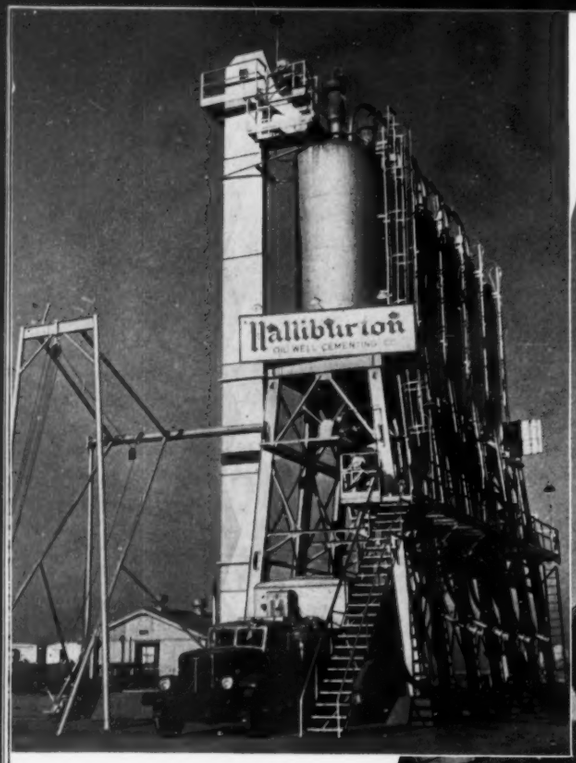
East Coast supplies include the production of crude oil in District 1: This figure may be expected to remain approximately stable at 80,000 bbl. per day. If any variation is experienced it should be upward in view of the recent discovery in Virginia which adds this state to the list of oil producers, but even without this new production, 80,000 bbl. per day output for District 1 is not an excessive anticipation for the balance of 1942. By reversing the flow in existing pipelines and utilizing these lines to maximum capacity an additional 163,000 bbl. per day of petroleum products can be moved into the Eastern area. Both production and pipeline movement cannot be expected to increase substantially above these figures without additional new building, which will be considered below. Barge movement on the Great Lakes, up the Ohio River and to the West Coast of Florida may be expected to account for a further 106,000 bbl. Testimony has recently been offered before the Senate to the effect that the movement through the Great Lakes could be greatly increased. While this is a distinct possibility time would be required to construct the additional tugs and barges needed to expand the movement of supplies by this route. From a conservative point of view it is safe to assume that the figure will stand at 106,000 bbl. per day for the remainder of 1942. These sources, local production, pipeline and barge transportation, furnish District 1 with a total of 349,000 bbl. of petroleum and products per day.

Railroads are, however, the greatest single factor in supplying the eastern territory since the movement of tankers has been restricted to military supplies. At present some 54,000 tank cars are bringing oil products into District 1 at the rate of 225 bbl. per car with a 16.5 day turn around. Since this analysis is based on the premise of nation-wide rationing for the conservation of rubber in the near future, the corrolary benefits to the supply situation in the East must also be taken into account. In a statement to WORLD PETROLEUM's representative, the American Railroad Association has estimated that an additional 15,000 tank cars would be released from service elsewhere in the event of nation-wide rationing. The turn around time could also be cut to 15 days. In producing these figures the Association had taken into account the ability of railroads to handle this additional number of tank cars even in view of their more than 25 percent increase in total traffic over the preceding year. It will be remembered that the Association's claims made last year as to the amount of oil that could be transported by rail have since been exceeded many times. If 69,000 tank cars are available for shipment into District 1 after the release of 15,000 additional cars, and if the turn around time can be reduced to 15 days. railroads alone could bring petroleum and products into District 1 at the rate of 1,035,000 bbl. per day. Added to the figure of 349,000 bbl. per day delivered by other means, total supplies for the East Coast by methods requiring no further construction would amount to 1,384,000 bbl. per day. Since minimum essential requirements for District 1 have been estimated at 1,504,548 bbl. per day there would be a deficiency of 120,548 bbl. per day for the balance of the year after all other available means had been adopted to reduce the consumption and increase shipping facilities into the Petroleum Coordinator's District 1.

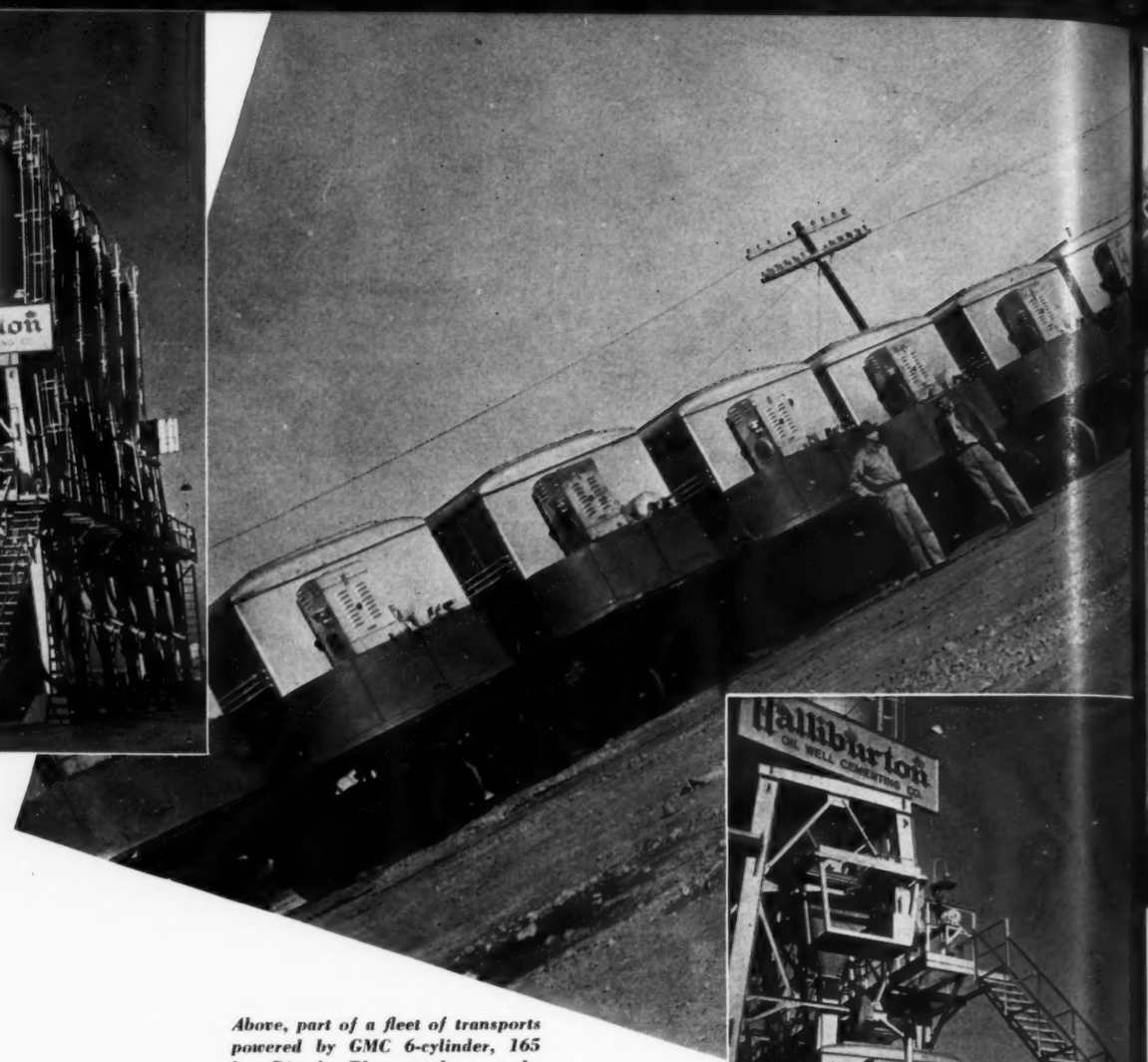
This deficiency of 120,548 bbl. per day must be withdrawn from existing stocks on the East Coast until means can be found to introduce larger daily supplies into this area. Relief may not be expected before the end of this year. Stocks at the beginning of the year available to District 1 amounted roundly to 90,000,000 bbl. of crude and products. During the period that must elapse before proper steps can be taken to reduce consumption and increase supplies, these stocks have been diminishing at the rate of a little less than 300,000 bbl. per day. By July 15 stocks will have declined to 30,439,000 bbl. of which 10,000,000 bbl. are minimum working stocks represented by oil in pipelines, bulk stations, refineries, etc., which cannot be withdrawn for consumption. About 20,439,000 bbl. will be available to supply the 120,548 bbl. per day deficiency, estimated above, from July 15 to December 31. If these remaining stocks are reduced at the rate of 120,548 bbl. per day they should be exactly sufficient to cover requirements for 169 days or from July 15 to December 31.

By December 31 the pipeline authorized by the President through the War Production Board is expected to start deliveries to Mount Vernon, Ind. from Longview, Texas. The line will be of 24 in. diameter and will have a capacity of 300,000 bbl. per day. From its eastern terminus connections will be made with other pipelines and oil will be shipped East by tank car and barge. Deliveries will be speeded up to an extent that will not only make up the 120,000 bbl. per day deficiency, but should permit replenishing storage that may be dangerously depleted by the end of the year. The route of the line has been surveyed and all preliminary engineering data compiled by the oil companies and work has already started under a high priority rating. The hope has been expressed that the line may be completed even before the end of the year.

In the meantime two important variables are apparent in the foregoing calculations: If the early winter should prove milder than normal, a very substantial saving in domestic heating oils would be possible; and if transportation of petroleum over the Great Lakes-New York Barge Canal-Hudson River route could be expanded as suggested by Walter P. Hadden and Guy W. Pinck at the recent Senate hearing, the critical East Coast situation would be somewhat relieved, even before the new Texas-Indiana pipeline comes into operation.



Above, a view of the Halliburton bulk cement plant at Bakersfield, California. It consists of a railroad siding over which cement is delivered from the manufacturer, moisture proof storage bins for various types of cement, a weight batcher for measuring and proportioning the cement for the individual jobs and a fleet of transport trucks.



Above, part of a fleet of transports powered by GMC 6-cylinder, 165 h.p. Diesels. These trucks carry the cement from the bulk plant located in the field to the well. If more cement is delivered than required, it can be returned promptly in the same trucks without loss due to moisture.

Above, dry bulk cement being weighed out and proportioned to the individual job just before the bulk truck leaves for the well.

Increased Efficiency

Elimination of Waste

through....

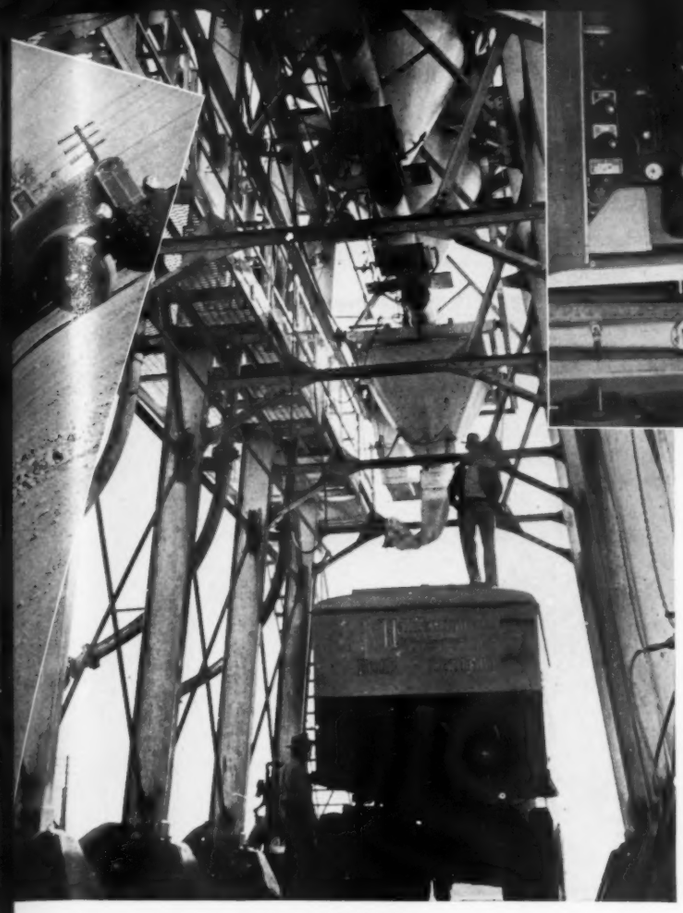
BULK CEMENTING

By C. P. Parsons, vice president

Halliburton Oil Well Cementing Co.

BRIEFLY, bulk cementing is the handling of cement in dry bulk form, instead of in sacks, for oil well cementing purposes. Compared with handling cement in sacks, it is a highly efficient and clean-cut method which makes the use of sacks obsolete.

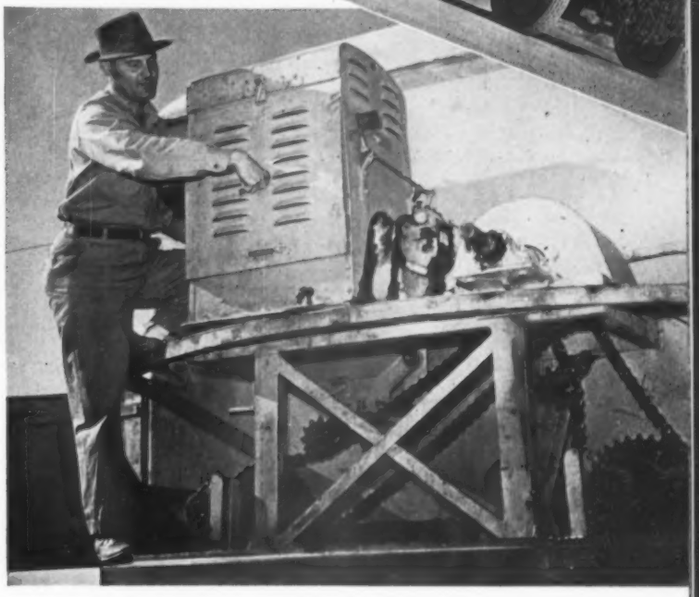
For many years the disadvantages of handling cement in sacks have been obvious. A line of sweating men picking up sacks from a huge pile and carrying them to a little red mixer was one of the most romantic sights in the oil fields, but it was also one of the most wasteful. Cement in storage, either in a dealer's warehouse or an oil operator's warehouse, is affected by time and by the extent to which the warehouse fails to pro-



Above, a close-up of the weight-batcher through which bulk cement is accurately measured into the truck. In this operation a sack of cement is exactly that; with no loss in the discarded bags.

Above, the scales are set controlling the weight-batcher between the storage bin and the transport. An automatic recorder punches a ticket when the desired amount of cement is in the weight batcher.

Below, one of the GMC 6-cylinder Diesel transports, loaded and on the way to the well. Cement is delivered at the time it is needed with no deterioration through storage on the ground at the well.



Right, on arrival at the well an auxiliary motor drives the screw conveyors which feed cement from the transport into the mixer.

All but one of the photographs in this series on bulk cementing were taken by Andrew Boone for Globe Photos

tect the cement against moisture. Cement may become dry-caked, wet-caked or lumpy, which affects its various physical properties and interferes with proper mixing.

Prior to the actual cementing operation the cement in sacks is hauled out to a well from a warehouse and piled on the ground. In the early days wooden boards were placed on the ground on which to pile the cement and a tarpaulin was used to cover the cement, but the use of these precautions gradually diminished. The cement is left on the ground for various periods ranging from a few hours to days or even weeks. Being exposed to the weather, the absorption of moisture through the sacks caused a gradual caking of the cement, and if exposed long enough or if rain hit the pile, the cement became lumpy. Caked cement interferes with proper mixing and many thousands of sacks of cement have been condemned at wells because of lumpiness.

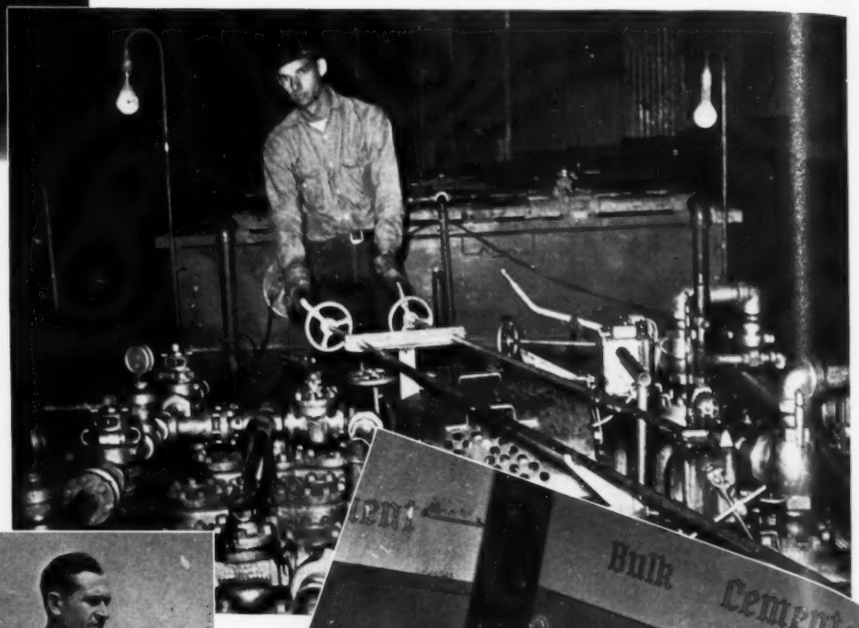
When a well is ready for the cementing operation, a line of men, consisting of the drilling crews and extra men hired for the purpose, pick up the cement sacks from the pile on the ground and carry them to a cutting table attached to the edge of the cement mixer. Two men at the cutting table, one on each side, drag each cement sack across a knife which cuts the sack open and the cement falls out of the sack into the mixer. The partially empty sacks are tossed aside. There is considerable waste because the extremely fast mixing of cement for oil well cementing purposes does not allow sufficient time for the men to shake all of the cement out of each paper sack. They merely have time to draw the cement sack across the cutting knife and let whatever amount of cement will fall out of the sack of its own weight, and then toss the broken sack and part of the cement away. The time available for cutting and dumping a sack of cement varies from three seconds in the slowest mixing to one second for the fastest. The waste of cement during the dumping has been estimated at from two percent to ten percent and may be even higher.

Each sack of cement weighs approximately 100 pounds, and handling sacks at a well ranges from reaching upward and pulling them off the top of the pile to stooping down and lifting them off the ground. They are then carried to the cutting table. When a man is fresh at the beginning of a job this is not much of a strain, but as the job continues fatigue begins to set in and slows him down, affecting the speed and uniformity of mixing the cement. While there have been few legitimate minor injuries to normal men when handling cement in sacks, there have been numerous cases of "malingerers" who have instituted damage suits for injuries allegedly due to strains, to cement getting in open wounds, in the eyes, etc. Extra men hired for dumping cement are pick-ups who work only a short period of from twenty minutes to forty-five minutes.

Summing up the disadvantages of handling cement in sacks for oil well cementing purposes, they are as follows: (1) Dry caking of the bottom layers of cement when sacks are piled high in storage. (2) Caking and lumping of cement

Above, having reached the well shortly before the cementing job is to begin the trucks are placed in position to feed the dry cement directly into the mixer which may be seen in the foreground.

Below, a cementer operates the controls of the cement truck while mixing cement. He watches the dial of an automatic weight indicator which shows the weight of cement slurry being mixed.

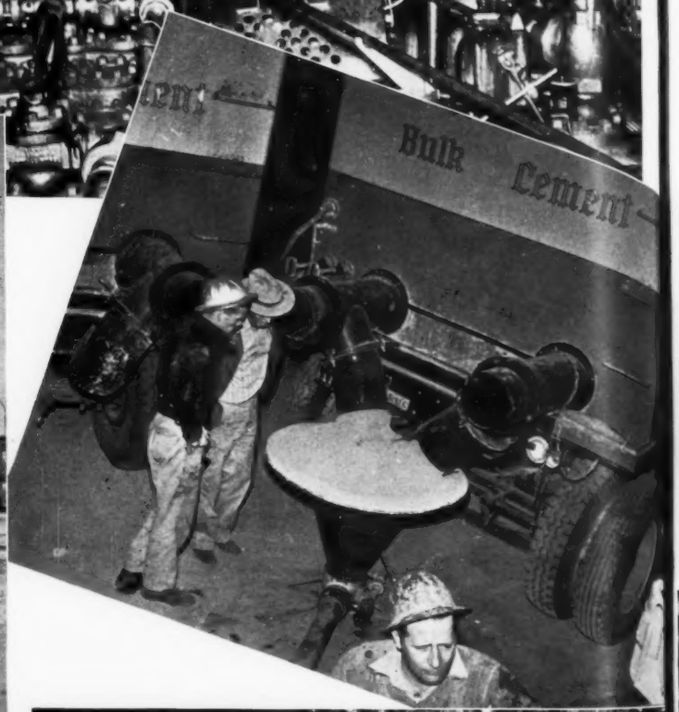


improperly stored against weather. (3) Exposure to weather while being hauled from storage to a well on the open bed of trucks. (4) Caking and lumping while the sacks are piled on the ground at a well, which exposes the bottom layer to dampness from the ground, and the rest of the pile to moisture from the atmosphere and the rain. (5) Industrial hazards while the cement in sacks is being carried from the pile to the cutting table and dumped into the mixer. (6) Fatigue slows down the mixing and affects uniformity. (7) Waste of cement which remains in the partially emptied sacks when tossed aside after being hurriedly dumped into the mixer. (8) Waste of paper sacks which are unfit for further use.

Bulk cement is matching the high degree of efficiency that has been attained in other phases of oil well cementing. It was introduced to the oil fields by the Halliburton Oil Well Cementing Company at Salem, Illinois, two years ago. Proving beneficial to the cementing service there, it was extended to other parts in Illinois, California, Texas and Kansas. Plants are now being constructed at Levelland, Texas; Haynesville, Louisiana; and Ada, Oklahoma. It is a major development which has come out of the sustained Halliburton program of improving its cementing service. A considerable section of this program has been aimed at taking the guess work out of oil well cementing and bulk cementing, by eliminating the error due to waste and spoilage of cement; this means that a sack of cement really delivers 100 pounds of cement to the well.

The proper handling of cement in bulk from the cement manufacturing plant to the Halliburton mixer for oil well cementing purposes, requires special equipment. Halliburton owns a fleet of special railroad freight cars which transport the cement from the manufacturing plant to the bulk plants located in the oilfields and the process from there on is illustrated step by step in the accompanying illustrations. The cement is unloaded from the cars into steel storage bins arranged to handle different types and brands of cement. The cement is weighed into a fleet of bulk cement trucks equipped with weatherproof tanks which

Above, cementing plugs are placed in the casing: one is placed ahead of the cement and the other behind the cement, to serve as a barrier between the cement and the circulating fluid in the well.



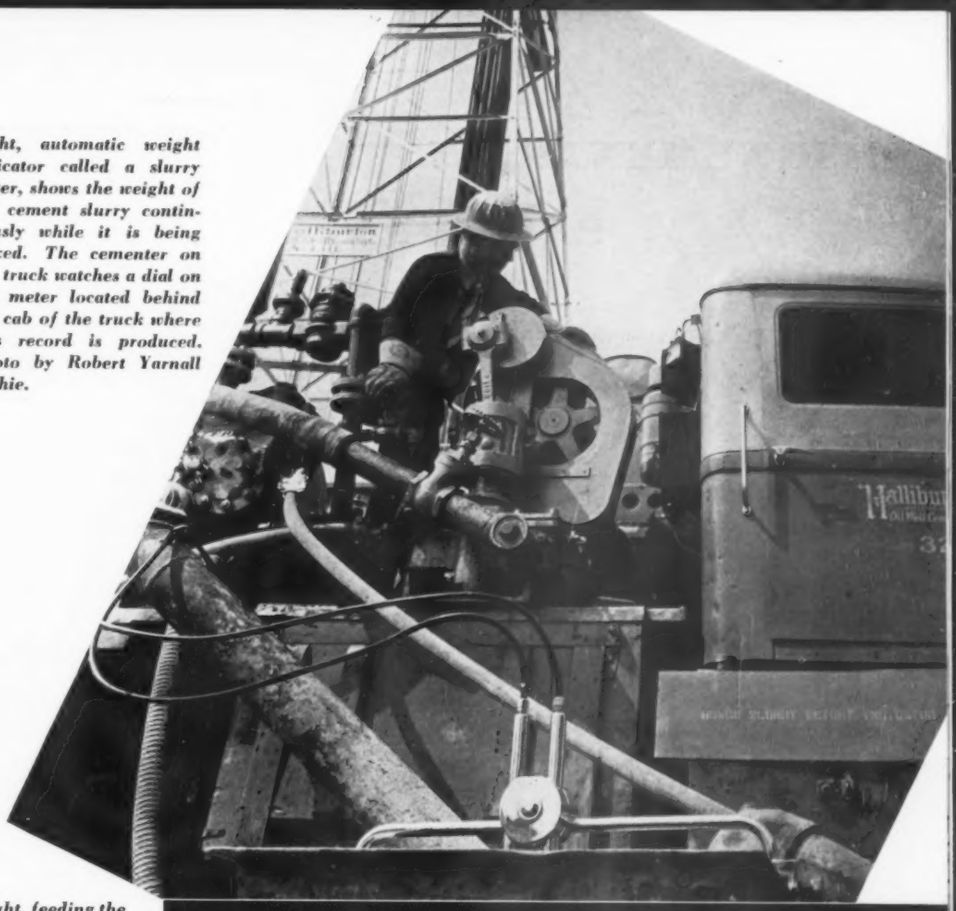
Right, a cementer inspects his slurry; frequent inspection and constant checking assure uniform consistency.

carry the cement to a well and feed it directly into the Halliburton mixer. The feeding is done by a mechanical screw conveyor which is part of each bulk cement truck. The uniform feeding of fresh cement, uncaked and without lumps, into the mixer gives more uniform and faster mixing. It is a clean-cut and efficient operation in keeping with the highly efficient red cementing trucks which mix the cement and pump it into a well. It gives one a great feeling of pride and satisfaction to see the engineering teamwork of the bulk trucks and cementing trucks at a well. It is less spectacular than the hectic handling of cement in sacks, but the rough-necks and drillers can go along with their regular duties, instead of having to pitch in and man-handle many tons of cement.

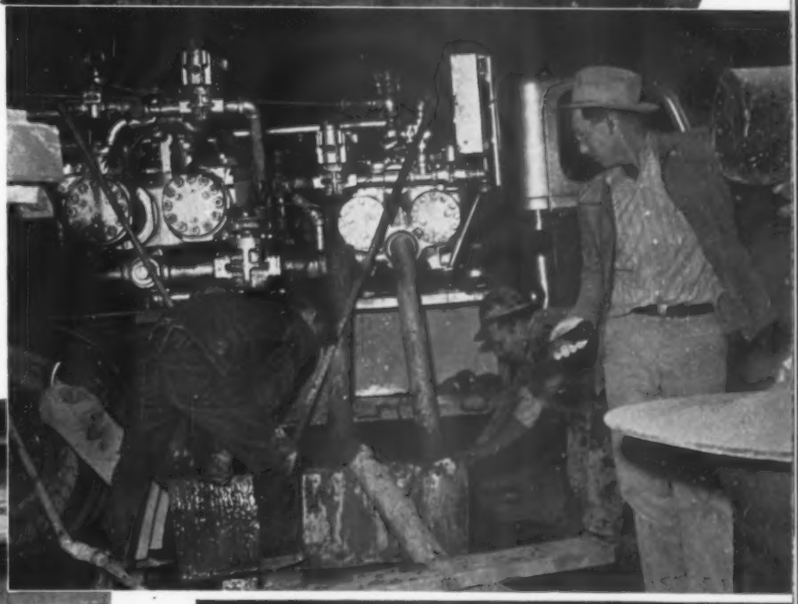
Summarizing the advantages of bulk cementing: (1) Eliminates caking and lumping of cement while in storage. (2) Protects cement against weather while being hauled to a well. (3) Eliminates caking, lumping and spoiling of cement at a well. (4) Eliminates waste while dumping the cement into the mixer. (5) Eliminates industrial hazards. (6) Eliminates extra work and fatigue on drilling crews. (7) Eliminates extra pick-up labor necessary to dump sacks. (8) Eliminates duplicate transactions and details of accounting. (9) Cement which is unused at a well is immediately hauled back to the bulk plant instead of being left on the ground in sacks. (10) The addition of admixes, such as bentonite, etc., can be more efficiently done at the bulk cement plant than at a well.

Left, the screw conveyors in operation feeding cement directly to the mixer. Fresh uncaked cement is delivered at a rate that is unaffected by manual fatigue.

Right, automatic weight indicator called a slurry meter, shows the weight of the cement slurry continuously while it is being mixed. The cementer on the truck watches a dial on the meter located behind the cab of the truck where this record is produced. Photo by Robert Yarnall Richie.



Right, feeding the bulk cement into the mixer is regulated according to the requirements of the cementing pumps.



In the two pictures below may be seen the periodical cleaning out of the transport and the special hitch between trailer and bobtail.

REFINEMENTS IN CALIFORNIA DRILLING TOOLS

Important Improvements in Oil Well Instrumentation and Control Coupled with the Trend Toward Portability.

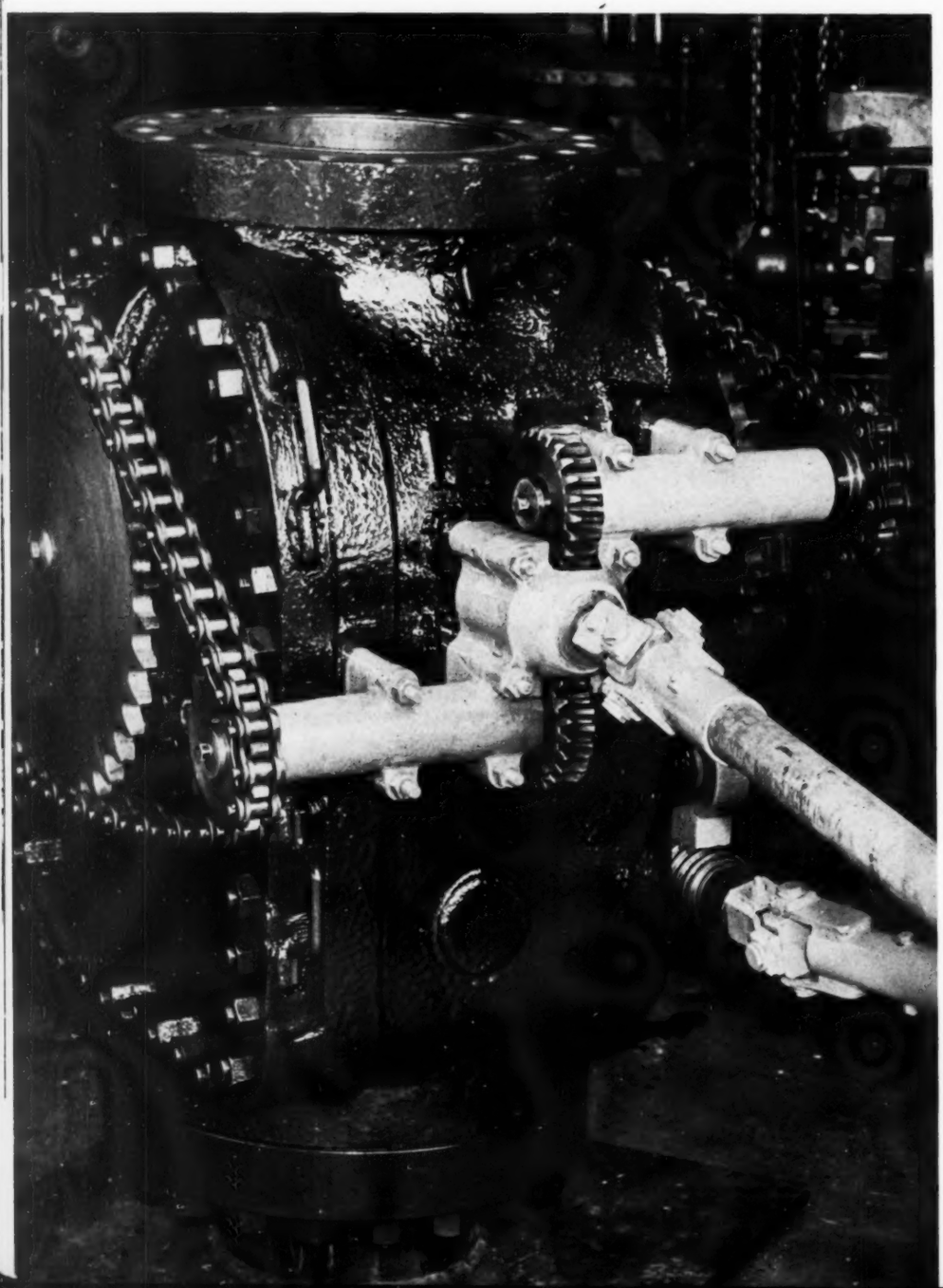
By Nicholas A. D'Arcy, Jr.
Emsco Derrick & Equipment Co.

RECENT drilling operations in California have been interesting from many angles. Deep drilling continued unabated and drilling to depths of 1800 ft. to 3500 ft. noticeably increased. Tools and smaller equipment were noticeably refined and improved. As much of the work was of an exploratory nature, it is only natural that increased attention be given to items assisting in drilling control through instruments and records.

Increasing interest has been evidenced in maintaining an accurate record of the time required to drill each foot of hole. The drilling time recorder charts this time. This record effectively locates the soft and hard zones and assists in correlating various formations. At present it is necessary for the driller to set the instrument each time a foot of hole is drilled and to facilitate this the kelly is marked off in one foot intervals. Correlation of the drilling time recorder chart and electric logging chart assists in identifying the structure. The drillogger gives a complete graphic record of all vital drilling variables. A continuous chart records the rate of penetration of the bit, the weight upon the bit, rotary table speed, pump pressure, and torque transmitted by the rotary machine. By a study of the five curves plotted by this instrument one is able to determine the fastest drilling procedure for any particular formation. The complete chart will also give a record from which the nature of the formation can be interpreted. It has provided extremely interesting information regarding causes of twists-off, stuck pipe and other serious drilling problems leading to fishing operations.

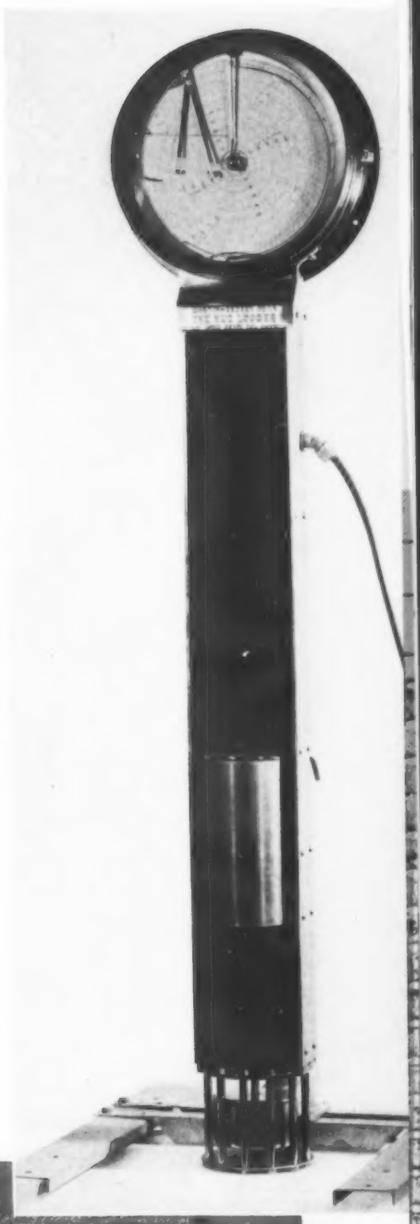
The mud logger provides a continuous graphic recording of the viscosity of the mud in centipoises and the weight of the mud in pounds per cubic foot or its equivalent. The chart drawn by this instrument gives a picture of the condition of the mud which cannot be obtained through periodical checks. It is interesting to note the cycles through which the mud passes, the chart definitely indicating the time required in circulating a given portion of mud. From this chart one can determine the exact portion of a body of mud requiring additional weight material or other chemical treatment.

California operators have almost universally



Combination drill gate and pipe packer tested to 6,000 lbs. which packs off both around the drill pipe and the open hole.

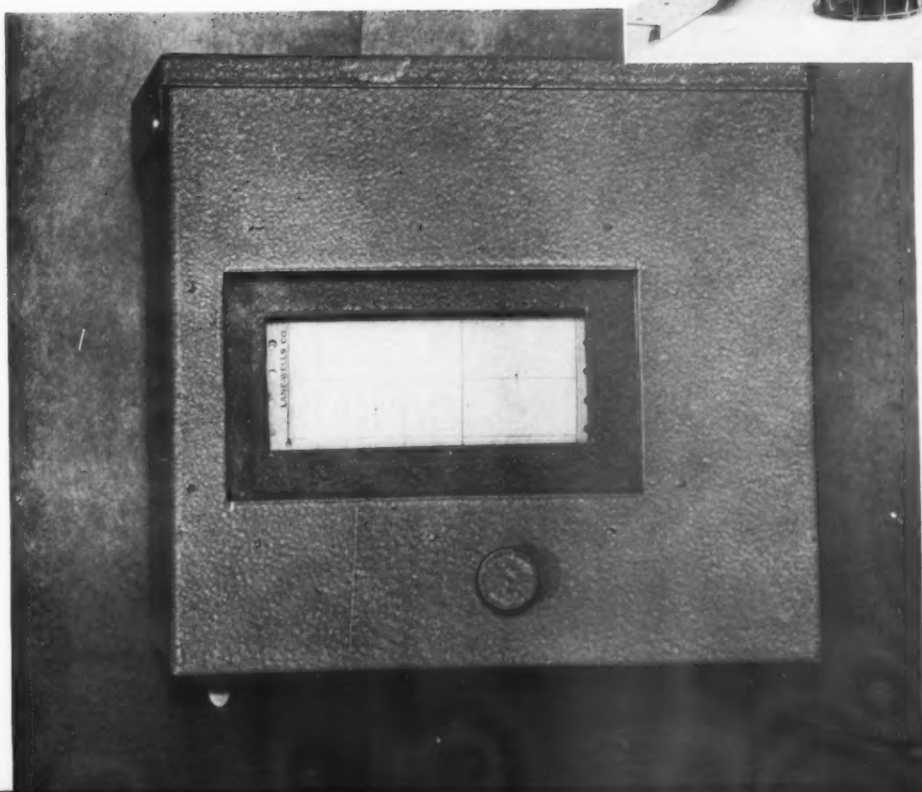
Left, bits with new type cutters; the outside row of teeth cut in a plane perpendicular to the inside row.



Right, the mud logger provides a twenty-four hour continuous chart of the viscosity and weight of the drilling fluid.

adopted better than Grade D drill pipe. In view of the existing national emergency it is of even greater importance to purchase tubular goods that will yield long life with safety. The use of shrink grip tool joints is increasing and new methods of applying the joints have been developed. At least one California operator has adopted the practice of breaking in tool joints thoroughly by a method of increasing gradually the torque applied to new joints. The results obtained were very satisfactory and warrant careful study.

Drill collars have seen comparatively little change during the past year, although three rather important innovations have been developed. Subs and drill collar threads are mated in the factory by one manufacturer. They are then carefully worked in under predetermined torques to make sure there is no tendency for the threads to gall. Collars treated in this manner have proved quite



Right, the drilling time recorder shows time in minutes required per foot of penetration.

Above, mating and working in drill collar and sub threads under predetermined torques to approach field conditions prior to shipment. On the facing page is illustrated a comparison between the records of the drilling time recorder chart on the right and electrolog curves; note correlation between the two records.

satisfactory and the operator is insured of the threads receiving careful inspection before installation and adequate thread lubricant on each joint. Experiments have been conducted on flame hardening the shoulders of drill collar boxes and pins. This extremely hard surface tends to prevent galling of the shoulders and apparently does not adversely affect the strength of the joint. One California operator has adopted the practice of making up drill collar joints with standard tongs and snatch block, and once the joints are made up they are never broken except for transportation. Drill collar pins and boxes have been cut with standard threads with a taper one inch longer than standard. This additional length of thread yields a stronger pin and is meeting with increasing popularity. The popularity of streamlined drill collars necessitated the development

of multiple grip wrap-around drill collar slips and multi-grip drill collar safety clamps. These slips provide a uniform grip around the circumference of the drill collars whether the collar is new or worn. The safety clamp fastens quickly and securely to the upper end of the collar and provides a shoulder against which the slips will hold in case control of the drill collar is lost.

Bits stuck in keyseat no longer bother two California operators. They have installed a stabilizing sub between the bit and the first drill collar. This sub is tapered from the outside diameter of the drill collar outwardly to the gauge of the bit. When pulling through a keyseat this tapered stabilizer sub guides the collars and the bit away from the keyseat and has probably prevented many time-consuming and expensive fishing jobs.

In an attempt to increase the efficiency of cementing jobs a caliper was developed to record continuously the diameter of the hole from the surface to the bottom. This instrument is useful in determining the volume of cement required for any particular cementing job as it provides a means of determining accurately the volume of material removed in excess of the theoretical bore. In addition to being useful in determining the volume of cement, the caliper has proven practical in taking measurements for other operations. One operator recently decided to set packers in an effort to make an open hole test and determined, through available information, the location where they desired to set the packer. Prior to setting it was decided to measure the hole with the caliper and the diameter was found to be in excess of 20 inches which would have defeated any attempt at packing off. The caliper indicated a small diameter a distance above the large hole and the packer was set successfully at the point indicated by the caliper. Volumetric measurements were taken to determine the amount of gravel packing required in two wells at the Los Angeles Harbor. The calculations varied from the actual quantity required on one well by one cubic foot and on the other well by six cubic feet, which is remarkable accuracy.

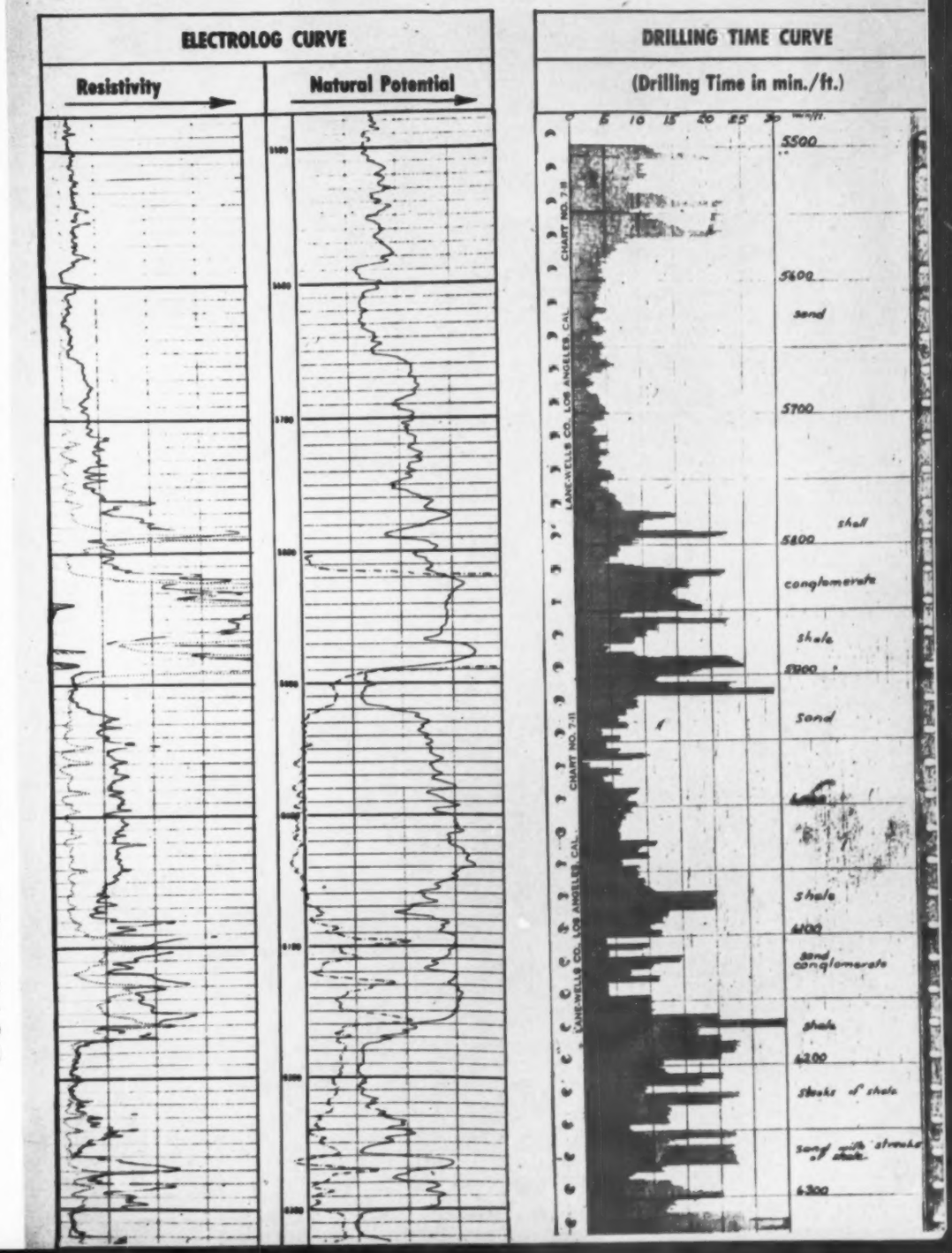
The rotary casing scraper has been introduced to remove the sheath or thin wall of hardened cement which usually adheres to the inside walls of casing after drilling out the cement tailings. This casing scraper is installed between the bit and the first drill collar and automatically cleans the inside wall of the casing in which it is run as it follows the bit down. The scraper automatically adjusts itself to all pipe thicknesses and compresses sufficiently to run through the joints of internal upset pipe.

Two new drilling gates or control heads have been introduced. A double control gate was manufactured for use with the trailer mounted mast type drilling rigs. This gate is greatly reduced in overall length making it possible to set it up completely in a shallow cellar. Combination drill gate and pipe packer tested to 6,000 lbs. is particularly useful in deep wildcats and when drilling treacherous formations. This packer has double acting rams and doors for both the drill pipe and open hole, all incorporated in one housing and all parts are effectively sealed. The upper doors which pack off the drill pipe can be changed easily for various sizes of pipe. The lower door effectively closes off the open hole. This gate is illustrated on page 34.

A four-piece forged bit head has replaced the old cast heads in one line of bits. The cutter supports are an integral portion of each of the four pieces. When the four portions of the bit are welded together into one piece, a very substantial support is provided for the cutters. This series of bits also features an interchangeable mud nozzle which discharges the fluid directly on to the cutters, providing adequate washing. The nozzles come with various size orifices to allow the operator to control the velocity of the mud discharged at the bit. The two-coned bit has returned to popularity in crooked hole formations. It is reported that a straight hole can be maintained when drilling with the two-cone bit carrying three points of weight in a formation that would be difficult to drill vertically with a three-cone bit with only one-half point of weight on the bit. A new type of inner bit cutter is now being featured in which the outside row of teeth is cut perpendicular to the inside rows. This gives added cutting surface where the wear is greatest and is illustrated on page 35.

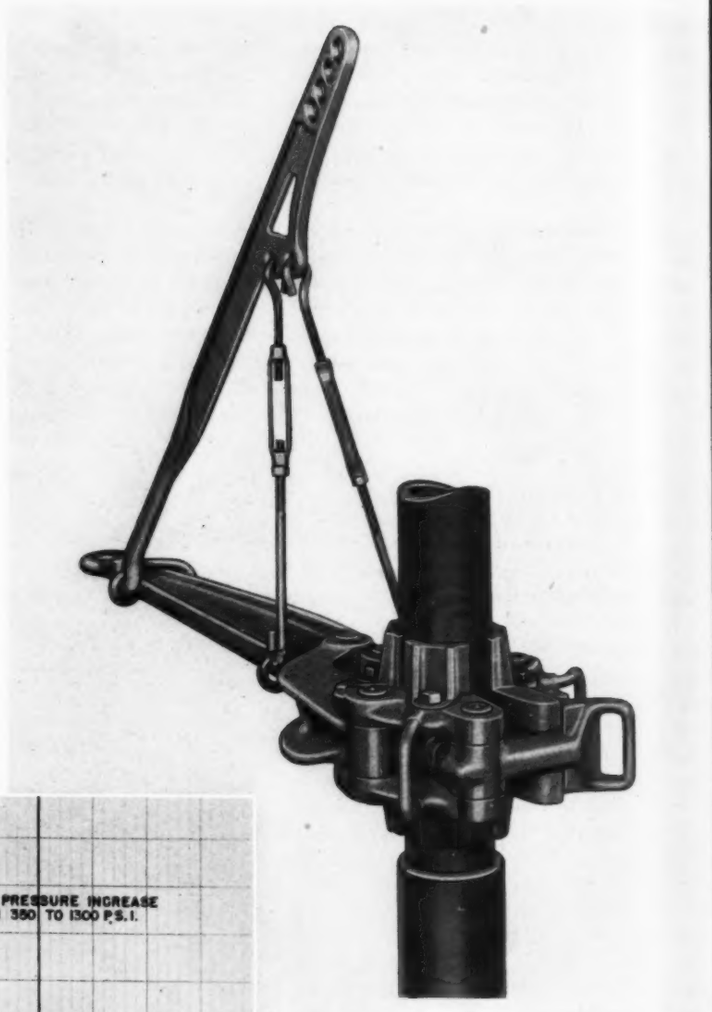
A rubber kelly wiper installed below the rollers

Drilling Time Recorder



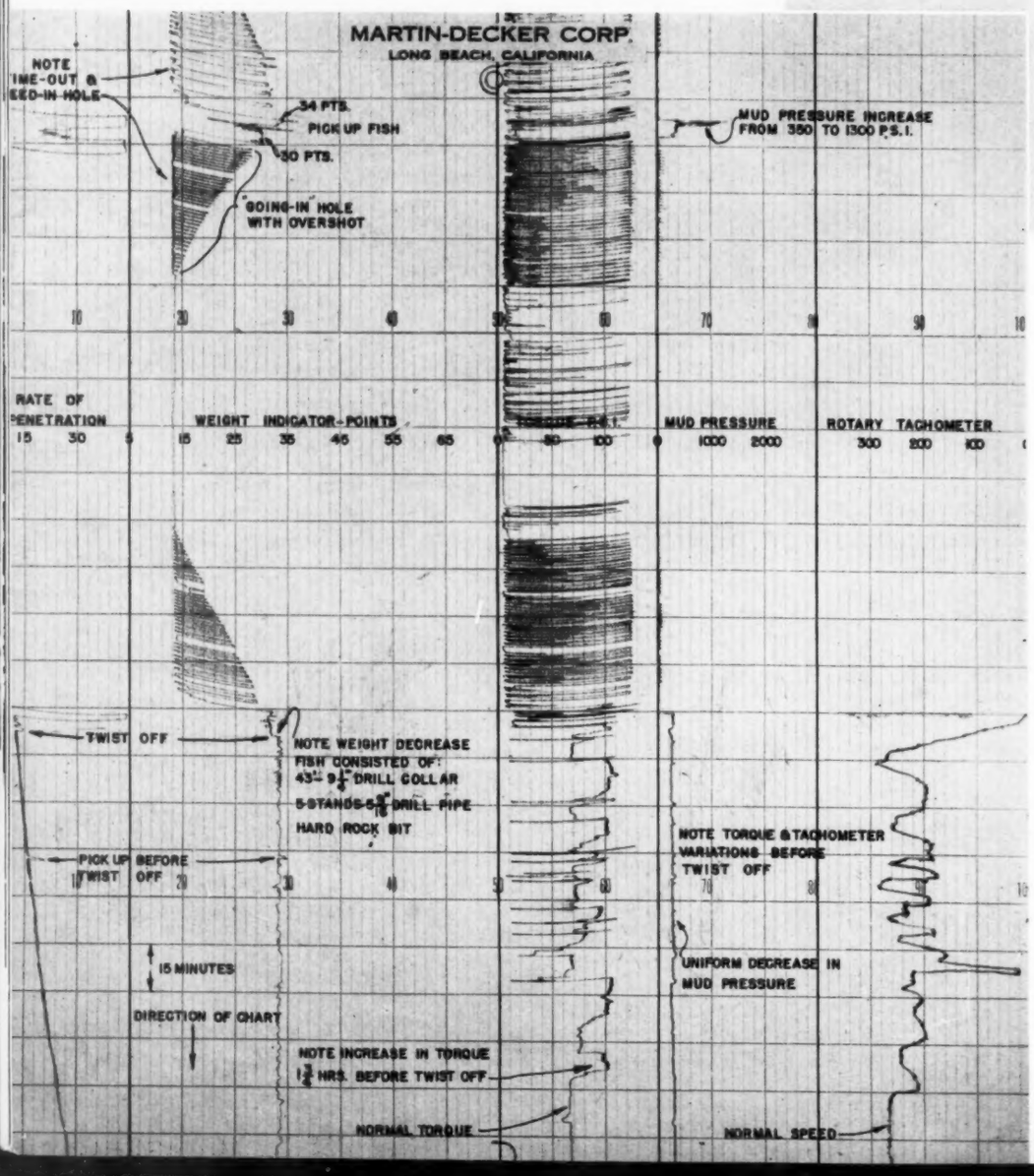
in the drill stem bushing has done much to keep mud out of the bushings and thus increase wear. The removal of the mud from the bushing also provides for more accurate readings on the weight indicator. A rubber pipe wiper efficiently cleans the drill pipe when it is being removed from the hole and has sufficient elasticity to allow the easy passing of tool joints and bits. The hug-tite drill pipe stabilizer is an interesting innovation. This type of stabilizer is expanded by an ingenious machine, then shrunk on to the drill pipe. The contraction of the rubber is so great that no motion is noticeable once the stabilizer has been installed. A casing centralizer has also been developed which effectively centers the casing in the hole assuring better setting.

The trend to use large size hose has continued. One manufacturer of steel rotary hose introduced a new ball bearing swivel so designed that it would move freely in three planes, making it impossible to get the connection on dead center at any time. There has also been a tendency to use this swivel connection when using rubber hose as it provides a very free joint between the gooseneck and the rubber hose and between the hose and stand pipe. The pressure seal coupling has received universal favor on rubber hoses.



Tongs with jaws twelve inches long used in connection with drill casing.

Below, chart of drilloger prior to the time of, and after twist off. Note marked increase in torque, decrease in rotary machine speed and uniform decrease in mud pressure for a period of one and three-quarter hours before a twist off.



Short coupled hooks and connectors have been particularly adaptable for application in shallow drilling with portable masts. Many of the hooks and connectors have been directly connected to the side plates of the traveling block, eliminating entirely the upper clevis on the hook and lower clevis on the traveling block. One hook manufacturer has so designed his equipment that either a connector or triplex hook can be installed on the main body. This gives the operator the advantage of using the connector where a short coupled setup is particularly desirable and switching to a triplex hook when he desires to handle his swivel in the conventional manner.

Tongs have been developed with a series of jaws which can be used from 3½ in. to 10¾ in. diameter pipe. This allows the operator to use a single set of tongs from grass roots to the bottom of the hole by merely changing the tong jaws. In connection with the drill casing operations in California, special 12 in. long jaws have been

furnished to prevent crimping the drill casing. An interesting steel or compressed air powered rotary casing tong has also been used when drilling with drill casing. This tong provides uniform torque when making up the casing and is faster than spinning up with manila rope.

Acid treatments have been given a number of California wells in an effort to improve the condition of the oil sand at the completion of a well. Some operators have been adding 15 percent of limestone to the mud used in drilling through the oil zone. This 15 percent is based upon the weight of the limestone as compared to the weight of the dry solids in the mud. The limestone impregnated mud produces a cake readily attacked by acid. Treating the producing zone with a solution of 15 percent commercial hydrochloric acid, dissolves the limestone and causes the mud cake to sluff off, cleaning the oil sand. The acid is, of course, treated to prevent emulsion and with a surface tension depressor and inhibiter to prevent the acid from attacking the steel. It is interesting to note that steel tanks have been used in hauling acid for over five years without leaks. Acid is also spotted in the hole prior to gun perforating on a theory that the pressure exerted by the shell explosion will force the acid out into the formation. Acid soluble cement has been used with some gun perforating jobs in which case an acid treatment will materially increase the diameter of the bullet hole in the cement permitting more effective drainage.

The drillogger charting five drilling variables on a continuous chart. One chart covers drilling for approximately one month.

Below, on the left is shown the open hole caliper closed. This instrument charts the diamter of the hole drilled recording any changes; on the right is shown the same instrument open with sensitive fingers prepared to record any changes in hole diameter.

Wildcatting and exploratory work is receiving additional impetus through government encouragement by means of excellent priority ratings. Activity in exploratory work should yield additional refinements in drilling equipment, particularly those portions assisting in the drilling control and developments that will facilitate easily transporting the equipment to new localities.

MARINE BORERS

Secret Destroyers of the Sea

By T. H. HANSEN
Pile Protection Company

With Scarcity of Materials and the Vital Importance of Oil Industry Marine Installations Attention is Directed Toward Preserving Piers and Wharves.

A typical 18 lb. creosoted pile, eight years old which supported refinery pier at Brighton in the Gulf of Paria; without the toxic refill treatment, it may be seen that the pile is practically destroyed.

REPLACEMENT of oil companies' marine installations, particularly in tropical waters, has frequently proved a costly project often involving delays and inconvenience in loading and discharging tankers and in bunkering cargo vessels. While a certain amount of dock and pile deterioration occurs in northern latitudes, the problem is far more acute in tropical waters where so large a proportion of oil company marine installations are located. Since proper pile protection can be achieved at a cost far below replacement, consideration of protective methods available is economically warranted in normal times; during the present emergency and in the face of critical shortages, even more serious study of repair, rehabilitation and protection of wharves and terminals is imperative. A total saving to the oil industry amounting to hundreds of thousands of dollars annually may be effected by the use of pier protection methods now available.

Three main types of marine borers are responsible for the extensive destruction of wharves and piers. Their activities are virtually universal but it has been determined that the life of creosoted piles is much shorter in tropical than in northern waters. The creosote, of course, acts as a poison discouraging marine borer attacks as long as the wood is impregnated. Due to the higher solubility of creosote in warm water, its effectiveness is likely to be destroyed in two to three years in the tropics with destruction of the pile very shortly thereafter. Complete destruction of the pile is hastened by the fact that marine borers are active all year in tropical waters in contrast to a three to five month season in the north. Because creosote is leached out of the piles much more rapidly in warm than in cold water and because the borer is active throughout the year the problem of protecting piers and terminals is more acute in the tropics; but is by no means nonexistant in the temperate zone.

There are three main groups of marine borers. The first group, Limnoria, Chelura and Sphaeroma burrow on and just under the surface of the wood and the lace-like pattern of their burrows is easily discernable, since they usually start their initial attack on marine piling in the tidal area. The Limnoria, also known as the "Gribble," resembles a tiny crawfish and when full grown attains a size of about 3/16 of an inch in length and about 1/20 of an inch in diameter. As a group they are considered the most destructive and widely spread of all the wood borers of the sea. Limnoria bore by a vigorous action of the mandibles which close like a pair of pliers on the wood fibers and with a quick retractible motion of the head the wood is torn away. The wood passes through the digestive system and small fecal pellets are discharged at the rate of one every eight minutes when the animal is active. Several hundred of these tiny animals may work on one square inch of piling (they drill holes slightly less than 1/16 inch in diameter) working on several layers of the softer spring wood. They can swim a short distance which probably account for their distribution from pile to pile under an infected pier.

A second group, the Teredo and the Bankia drill holes inside of the wood. The Teredo is a worm-like borer with a small clam shell boring head.

It grows from the size of a pin point to four or five feet long and one inch in diameter, depending on the species and local conditions. Teredos enter timber through a pin hole and extend themselves by digging with their boring shell. The tail is located where the worm enters the timber. He feeds through the incurrent siphon of his tail and forwards his food through his gills underneath the skin of his body all the way to his mouth. The mouth, foot and boring tool are located at the other end of his body. Wood borings and food enter his mouth, pass through the digestive system and both are expelled through the excurrent siphon also located in his tail. The foot resembles a vacuum cup and when pressed against the wall of the hole enables the boring shell to rasp the wood in a clam shell bucket like movement 8 to 10 times a minute. It has been estimated that one full grown Teredo can lay 100 million eggs. As many as 100 entrances have been counted in one foot of infested piling, but the presence of these pests is difficult to detect because there is no indication on the surface that the Teredo is active inside of the pile. Whenever the water becomes polluted the Teredo can close his siphons for two weeks with no ill effect.

The third group is the Martesia, noted for its ability to destroy creosoted timber in southern waters. This is a clam-like borer which embeds itself in the outer surface of the pile. It attains a size of about ¾ by one inch when full grown and is very active south of Charleston, S. C. Very little is known about the biology of the Martesia, but we do know that they are less affected by the toxic fractions of creosote than any other borer and they will attack a heavily treated pile as soon as it has lost its oiliness.

It has been established that marine borers will not attack wood containing fresh creosote. Creosote, however, is soluble in water; therefore a pile placed under a pier is subject to the leaching action of the water aggravated by the rise and fall of the tide and the action of the waves. As soon as the creosoted pile has lost a certain toxic oiliness it is subject to attack by marine borers. The problem of pile protection against marine borers resolved itself into supplying automatically to the pile sufficient fresh creosote to establish a poisonous zone near the surface of the wood and below the water line. To meet this need the toxic refill method was developed by the Pile Protection Company of Jersey City. By this method a predetermined amount of fresh creosote travels down within the creosoted sapwood shell of the pile the same as the sap travels in the growing tree. When first adopted it was not entirely successful until the area exposed to tidal action was enclosed in a watertight jacket, because the continual lapping of water produced a decided leaching effect in the pile area exposed to the tidal action. In time the strength of creosote in this area was weakened to such an extent that marine borers were able to secure a foothold. The area exposed to suction and erosion on treated piles is also almost always the point of initial attack by marine borers. A watertight jacket prevents exposure of this vital area. With these jackets in place the creosote does not escape into the water in the tidal area, but continues down the tracheids or tube-like cells of the wood keeping the pile below the jacket, which is also the point most affected by tidal action, thoroughly saturated with fresh creosote. Toxic refill causes the pile to sweat. The lethal concentration on the pile below the jacket protects the pile against marine borer attack down to the mud line.

The fact that borers living within the piles die out and no new ones attach themselves to the piles thus treated was proved by more than 1500 inspections of the under water part of the pile. The results of these inspections and the 10 years service record indicate that the continuous saturation with fresh creosote will perpetuate the service life of piles as long as this treatment is continued, thereby greatly reducing replacement and maintenance costs.

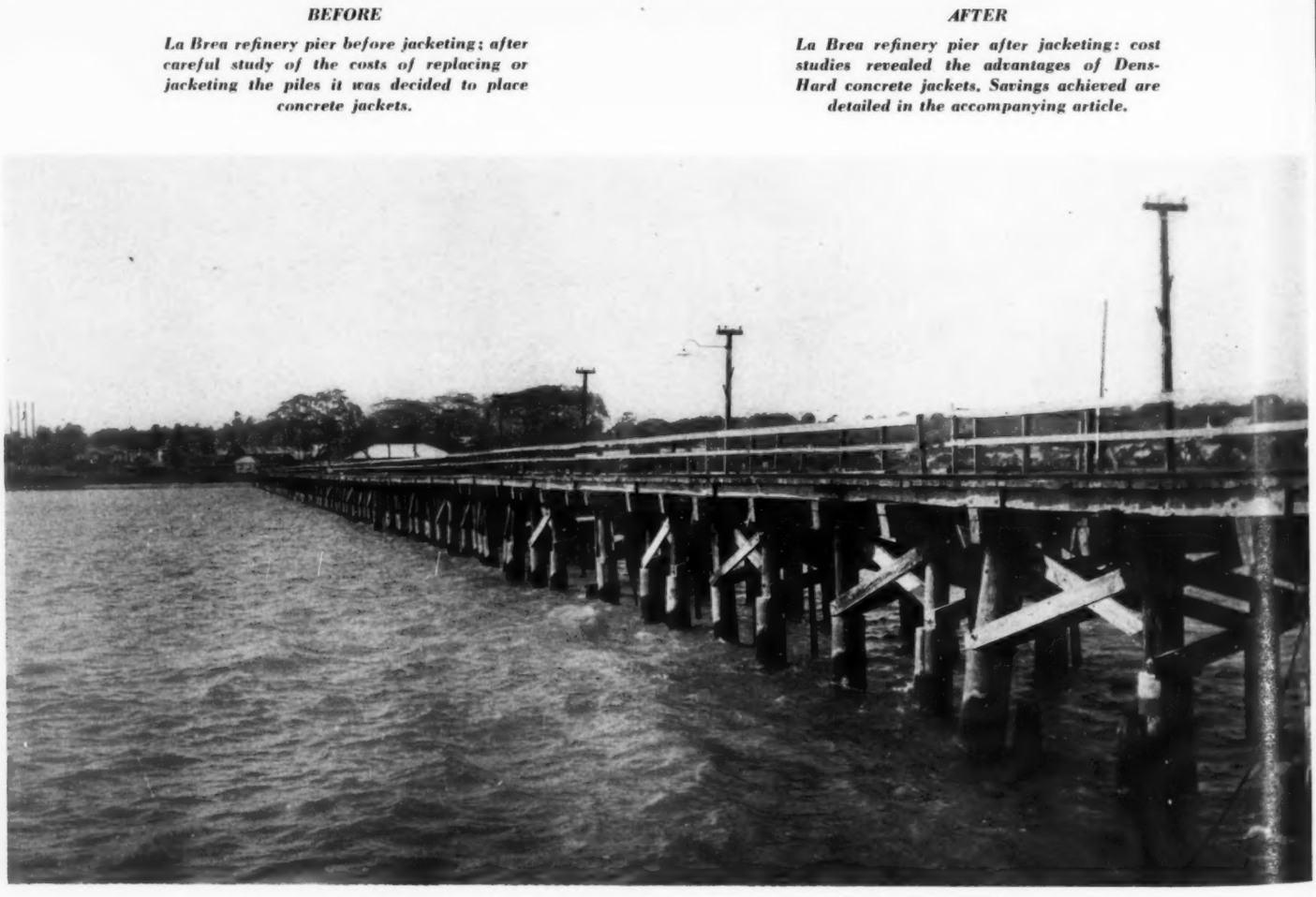
After reconstruction of the Brighton Pier in the Gulf of Paria, toxic refill was applied; the accompanying view shows the condition of the piles after several years exposure to marine borers as seen from the inspection walk under the pier.

BEFORE

La Brea refinery pier before jacketing; after careful study of the costs of replacing or jacketing the piles it was decided to place concrete jackets.

AFTER

La Brea refinery pier after jacketing: cost studies revealed the advantages of Dens-Hard concrete jackets. Savings achieved are detailed in the accompanying article.

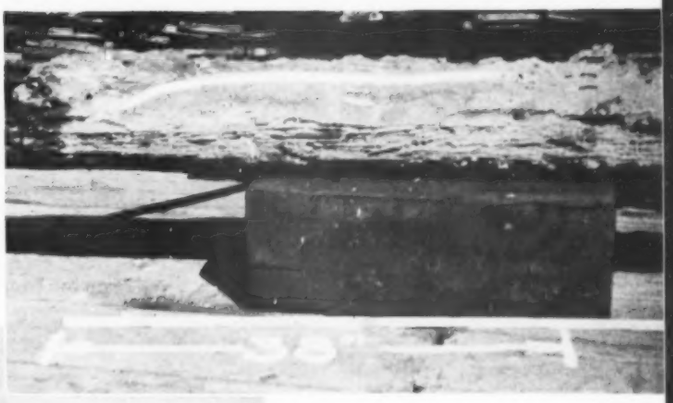


It will be seen from the foregoing, that a jacket, preferably of concrete, is a necessary auxiliary protection for piles subject to attack by marine borers. To meet this need the Pile Protection Company has developed the Dens-Hard reinforced concrete jacket. This jacket takes advantage of recent improvements in cement enabling it to resist the freezing and thawing cycles in salt water by the addition of vinsol resin and to prevent disintegration caused by magnesium sulphate in salt water. The water-proof surface of the Dens-Hard jacket is cast as an integral part of the entire concrete which provides a two to three inch cover over properly designed reinforcing. The concrete may be poured without coming in contact with salt water regardless of the length or condition of the pile.

Two applications of toxic refill and Dens-Hard jackets with data on costs are of particular interest to the oil industry. The first is the Brighton Pier in the Gulf of Paria between Trinidad and Venezuela. The pier is used mainly for loading oil and asphalt on tankers. It consists of 45 bents of 12 piles each and is 80 to 90 ft. long, standing in 29 to 32 feet of water having a three foot tide. Bearing piles have concrete jackets five long and fender piles have Muntz metal jackets protected by horizontal fenders. The pier is subject to a two foot sway when vessels of 10,000 tons are moored alongside. Some sections of this pier have been rebuilt making possible a ten year comparison with and without toxic refill. It has been found that the original cost of the pier plus necessary repairs and replacements for a ten year period amounted to $270,000; but the original cost of the pier plus repairs and installation and treatment with toxic refill for a ten year period amounted to only $170,000. The treated piles are still in excellent condition so every subsequent year may be expected to show further substantial savings above the $100,000 indicated for the first ten years of toxic refill treatment.

Application of the Dens-Hard jackets to the La Brea refinery pier also furnishes an interesting cost comparison. The pier was built in 1930 and by 1937 a number of the piles had to be replaced at a cost of $100. per pile. It was estimated that continued replacement of piles would cost $28,400 for the two years 1938-1939. Hence it was decided to apply Dens-Hard jackets to the remaining piles which would otherwise require replacement within the next two years. The jackets were applied over a period of three months without interruption of the traffic passing over the refinery pier. An accompanying diagram illustrates each step in the procedure. The total number of piles jacketed was 326 at a cost of $16,700 compared with a replacement cost (at $100. per pile) of $32,600. Since the service life of plain creosoted piles in this vicinity is six to eight years and there is reason to believe that the Dens-Hard jacketed piles will last 20 to 25 years there will be a substantial saving for each year over the seven year normal life of plain creosoted piles exposed to marine borer attack.

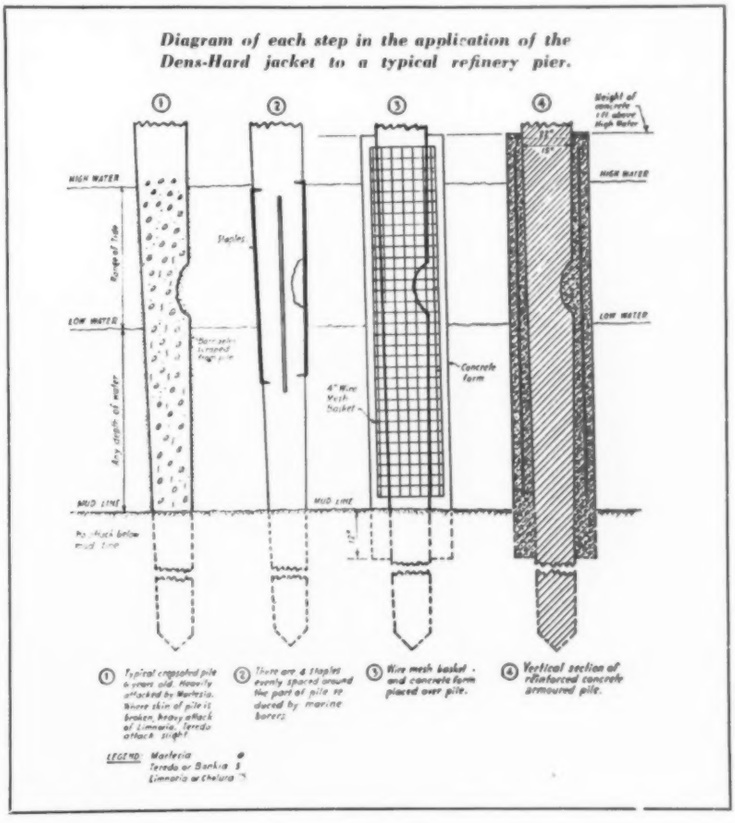
In view of numerous other examples of the time, labor and material savings made possible by toxic refill and the Dens-Hard jacket, as well as the two oil installations described above, there is reason to believe that use of these methods is particularly desirable at the present time when shipping and materials are scarce and important.



Right, the teredo lines its burrow with a tube of white lime which shows as a dirty white line. In the illustration on the right this line has been painted for greater visability. As many as 100 million eggs have been found in a single teredo.

Left, the work of another marine borer, the martesia. This borer is most active in tropical waters and is less affected by the presence of creosote being prepared to attack as soon as the initial oiliness has been leached out of the pile by the tidal and wave action.

Diagram of each step in the application of the Dens-Hard jacket to a typical refinery pier.


HIGH WATER
LOW WATER
MUD LINE
Staples
4" Wire Mesh Basket
Concrete form
HIGH WATER
LOW WATER
MUD LINE
① Typical creosoted pile 6 years old. Heavily attacked by Martesia. Where skin of pile is broken, heavy attack of Limnoria. Teredo attack slight.
② There are 4 staples evenly spaced around the part of pile reduced by marine borers.
③ Wire mesh basket and concrete form placed over pile.
④ Vertical section of reinforced concrete armoured pile.
LEGEND: Martesia
Teredo or Bankia
Limnoria or Chelura

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry — Edited by Dr. O. W. Willcox.

DRILLING

New Type of Slim-Hole Rotary Rig—Harry F. Simons in OIL & GAS JOURNAL, Vol. 40 (1942), No. 36, pp. 33, 35, 39-40, 42.

A new departure in slim-hole rigs has been taken by Shell Oil Co. for rapid penetration to 7,500 feet and beyond with 3½ inch drill pipe. The outfit is entirely wheel-mounted and can be assembled in a few hours after arriving at the location. Because the equipment will be moved less often than on shallower drilling, the actual hole-making operation was stressed in construction rather than the moving feature.

The entire rig is a departure from standard practice as are many of the parts. This is the first rig mounted on wheels which is propelled by the drilling engines instead of being pulled or driven by a separate engine. It is the first on which the carriage frame serves as the frame for the hoisting machinery, the compounding drive and the engines. The 120-ft. mast, which can be used for pulling thribbles, is the first of that height designed with a base which comes within the highway limit of 8 ft.

So far as is known Shell is the first company to use superchargers to increase the horsepower output of the engine for drilling. The rig is also equipped with special air controls which have both an automatic and flexible speed regulation. There is only one jaw clutch in the entire assembly and this is really not used as a clutch but as a shifting mechanism between the two sets of gears. All other clutches are of the friction type and the majority of these are air actuated. The drilling rig is entirely chain driven, the only gear being in the rotary table.

The derrick base, the method of handling the crown block and the provisions for raising the derrick are also unusual. The crown block is described partially by the term "floating."

Improvements in the Treatment of Crude Oil-Water Emulsions—R. C. Buchan, before AMERICAN PETROLEUM INSTITUTE, Southwestern District, Dallas, February, 1942.

Many oil emulsions may be broken up by water treatment with chemicals or treating compounds, of which a number are now being offered. These are useful in bringing a crude oil within pipe line specifications, but better than this is desirable. Experiments by several larger producers have followed two different trends of thought.

One thought was that emulsions should be superdehydrated, that is, treated to as low a water content as is possible in a single operation. The other thought was that the treated oil should be desalted in the field.

Superdehydration was accomplished in one of two ways. In some cases it was found that by carefully selecting chemicals and methods, the oil could be treated consistently to 0.1 percent and less impurities with a resultant salt content of 15 to 30 pounds per thousand barrels of oil. Although it was found that this is not a universally practical operation, it is an economical practice in fields where the adaptability of chemicals and methods make it possible and where the crude is segregated during transportation to the refinery. The second method tried was that of adding fresh water to the emulsion and separating the oil and water in conventional treating plants. This has not been very satisfactory, although salt contents can be greatly reduced. The main objections to the method appear to be the cost of fresh water and additional heater capacity, and the need for regulating the ratio of the volume of fresh water to the volume of production.

Desalting in the field appears to be generally uneconomical because the required additional instal-

DURING THE EMERGENCY
Baroid expects to render
SERVICE AS USUAL
Since the inception of the Baroid Sales Division, we have maintained field service engineers in, or adjacent to, all active oil fields of the United States. This service, in collaboration with oil company mud engineers, has resulted in large savings for the oil industry by reducing or eliminating drilling difficulties, by the saving of casing and in many cases, by the actual saving of wells.
It is the desire of the Baroid Sales Division to maintain this service throughout the emergency, insofar as possible, with whatever means are available.
BAROID SALES DIVISION
NATIONAL LEAD COMPANY
BAROID SALES OFFICES: HOUSTON • LOS ANGELES • TULSA
1943?
PATENT LICENSES, unrestricted as to sources of supply of materials but on royalty bases, will be granted to responsible oil companies and operators to practice the inventions of any and/or all of United States Patents Nos. 1,575,944; 1,575,945; 1,807,083; 1,991,637 and further improvements thereof. Applications for such licenses should be made to Los Angeles office.
BAROID PRODUCTS: Baroid and Colex, Aquagel, Fibrotex, Baroco, Stabilite, Aquagel-Cement, Smentex, Zeogel, Impermex, Micatex, Testing Equipment, Baroid Well Logging Service.

lation and operating costs do not compare favorably with the costs obtainable by electrical and chemical methods in refineries. An exception to this is where all the production in a field is brought to a central location and treating and desalting can be carried out in conjunction with the operation of a gasoline plant. An outstanding example of such an operation is carried on in the Ville Platte field in Louisiana. However, it is still a fact that each field is a new oil-water system, and must be handled accordingly.

OPERATION

Subsurface Disposal of Oilfield Brines in Oklahoma—Sam S. Taylor and E. O. Owens, in BUREAU OF MINES REPORT OF INVESTIGATIONS NO. 3603, January, 1942; 54 pages.

This report presents the results of a study of three oilfield brine disposal systems, two in the Fitts pool area, and one in the Moore pool area.

These systems, which are minutely described, treat and dispose of brines from about 1000 wells by injection into a subsurface porous stratum. The systems themselves are notable for their engineering and the use of an extensive brine-gathering system, which includes approximately 44 miles of pipe of various kinds. These three systems cost initially $701,300.

From observations and data gathered in this study the authors select certain conclusions and suggestions for emphasis. If necessary, the brine has to be treated so that when entering the disposal well it will carry no matter that could precipitate in the sand and block the pore spaces. This applies to brines from different sources which may be stable by themselves, but which throw out a precipitate when mixed in the disposal well.

Stabilization is effected by causing the precipitation of iron, bicarbonates, etc., by aeration and/or by treating with duly proportioned amounts of lime and aluminum sulfate. This precipitate is filtered off.

If the brine to be injected is found to be corrosive to iron or steel, the use of corrosion-resistant equipment between the filters and the disposal formation will facilitate the disposal of the brine if it has been conditioned adequately.

With brines of the type reported, the stabilization or removal of the iron compounds usually is the most important chemical change necessary in preparing the brine for subsurface disposal. When brines containing soluble iron compounds are conditioned in open-type systems, chemical treatment to control hydrogen-ion concentration (pH) is necessary to facilitate the efficient removal of the iron compounds. The dissolved-oxygen content of brines should be minimized before their injection into subsurface formations. Where oil-field brines are to be collected over extended areas and conducted through open gravity flow lines for long distances, the open-type brine-treating system is desirable. Where extensive gathering lines are used and the brine flowing through them to the conditioning plant is exposed to and agitated in the presence of atmospheric oxygen, due consideration should be given to the probable change that may occur in chemical characteristics of the brine during transportation. For maximum efficiency all brine-conditioning systems should be operated under at least part-time technical supervision.

Recent Advances in the Selective Shooting of Producing Horizons—Harry M. Ryder, before AMERICAN PETROLEUM INSTITUTE, PRODUCTION DIVISION, EASTERN DISTRICT, Pittsburgh, April, 1942.

In secondary oil recovery by use of water injection, control of water movement in the sand can be exercised by selective shooting, resulting in a substantial economic advantage. In selective shooting each individual sand layer within the oil bearing formation is shot, so far as possible, according to its permeability, porosity, oil saturation, water content and other conditions.

One of the requirements of a selective shot is to fracture each individual stratum in the pay formation to just the extent necessary, so that the sand will take, as nearly as possible, the exact amount of water which will result in a minimum residual oil saturation.

The author draws extensively on experience in the Bradford and Berea fields. From his operating data he is able to confirm the conclusion, drawn by the Bureau of Mines from experimental work, that more oil is swept out of the sand when the flooding water has a high rather than a low velocity, which contradicts an opinion that has been heretofore accepted. Hence the aim of selective shooting must be to create the proper amount of fissuring of each sand; the size of the shot is varied accordingly, instead of setting off the same uniform charge at each horizon. Naturally, each producing zone must be carefully studied beforehand, but from the data submitted it is evident that the care will be well repaid.

REFINING

Prediction of Octane Numbers and Lead Susceptibilities of Gasoline Blends—Dubois Eastman, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 33 (1941), No. 12, pp. 1555-1560.

Data on pure hydrocarbons and experience with commercial gasolines have shown that the octane values of blends of saturated hydrocarbon types, such as paraffins and naphthenes are related arith-

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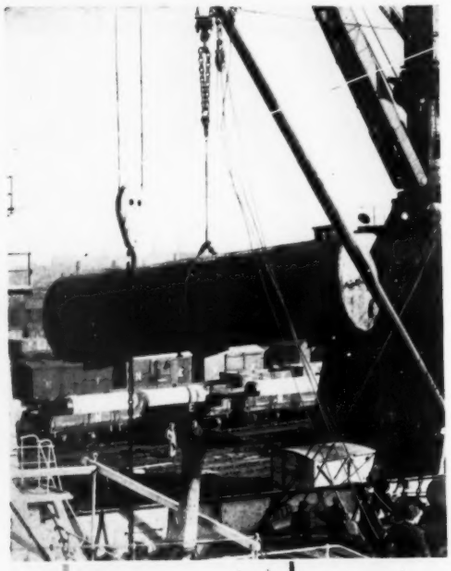

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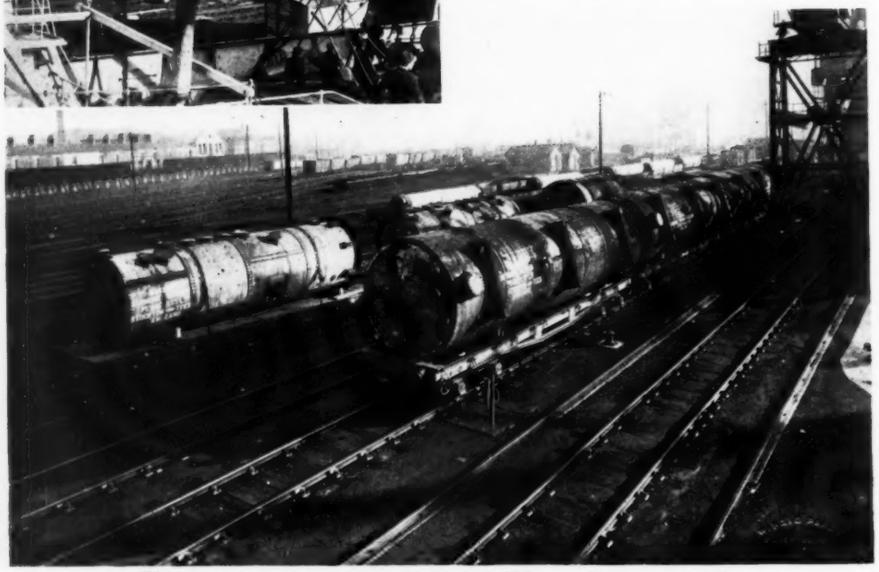

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metically to the octane numbers of the components and to the relative proportions in which they are blended. If, however, these materials are blended with unsaturated fractions containing olefinic or aromatic types, substantial deviations from an arithmetic relation are commonly encountered.

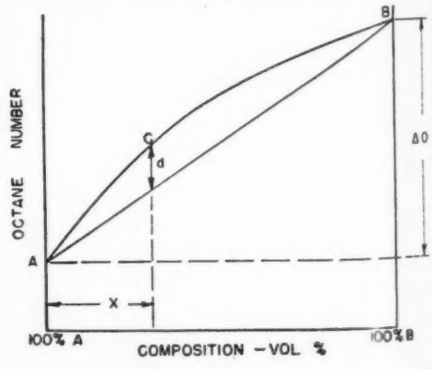
The behavior of a typical two component blend of the latter type is illustrated in the accompanying figures, wherein values of blends of base stocks A and B are plotted against the relative proportions of the two stocks blended. The octane values of the two base stocks are shown as points *A* and *B*, and a typical blend is shown as point *C*. The deviation of *C* from the straight line connecting *A* and *B* represents the deviation (d) of this blend from an arithmetic blending relation. The magnitude of the deviation has been found to depend on the relative proportions in which the two stocks are blended, the difference in octane number between the two base stocks used, and the difference in character between the two gasolines.

In studying a large number of blends, it has been found that curve *ACB* can be satisfactorily represented as a skewed parabola such that for blends of any two base stocks the ratio $d/\sqrt{x}$ is a constant when x is taken as the volumetric fraction of either A or B in the blend, whichever is the smaller.

It has also been found that a factor may be obtained which is dependent only on the difference in character of the stocks blended if this ratio $d/\sqrt{x}$ is divided by the difference in octane number of the two stocks. Thus:

$$c = \frac{d}{\sqrt{x}\,\Delta_0}$$

where c = blending coefficient which is dependent only on the difference in character of the two stocks
d = deviation of observed octane value from arithmetic average
x = volumetric fraction of either stock in the blend, whichever is smaller
Δ_0 = difference in octane number between the two stocks blended



The difference in character of the two stocks is conveniently measured in terms of their respective octane sensitivities, where the term "sensitivity" refers to the difference in octane number as measured by the C. F. R. Research (1939) method and by the C. F. R. Motor or A. S. T. M. method. It has been found that values of the blending coefficient, c, are not the same for the Research and Motor methods and that the respective values of c_M and c_R can be correlated empirically with the sensitivity factor ΔS^2.

The solving of special cases is facilitated by charts and tables accompanying the paper.

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Petroleum Refining Methods Available for Wartime Demands—J. F. Thornton and W. C. Dickerman, Jr., before AMERICAN INSTITUTE MINING METALLURGICAL ENGINEERS, New York, February, 1942.

War requirements are making severe demands on the petroleum industry. The chief of these demands involves a greatly increased production of 100 octane number aviation gasoline, which in turn involves the production of larger amounts of isopentane and alkylate (isooctane) for blending with high grade base gasolines. To make the alkylate it is necessary to produce larger amounts of isobutane. Added to this large problem of supplying aviation gasoline are the problems of supplying adequate amounts of toluene for explosives, and butadiene and styrene for artificial rubber.

In taking stock of ways and means of meeting these demands the authors remind the refiners that an amazing variety of processes is available for making these vital products. Their problem is to fit these processes in their plants in ways that will require the least time and put the least burden on the furnishers of steel and engineering services. Standard designs should be used wherever possible. Besides that, no source of essential material should be overlooked or left unexploited. Isopentane must be recovered from every source, and gas fields and natural gas plants especially must install the necessary facilities. All available crudes that give a high octane straight run gasoline must be earmarked for aviation base stocks. These base stocks must be deprived of as much of their sulfur as possible, for which purposes good desulphurizing processes are available. The supply of base stock may also be increased by short cuts on gasoline distillates. Catalytic cracking processes generally yield excellent base stocks, and where new construction is needed these should be given consideration. Catalytic naphtha isomerization also comes into view here.

Besides isopentane and a good base stock, alkylate is required for 100 octane gasoline. This is now made catalytically by a simple process, for which a supply of isobutane and butylene is needed to obtain these. All natural or cracked petroleum products must be under contribution, with special reference to the gas fields. Catalytic cracking processes produce much isobutane. Butylene, the other essential ingredient for alkylate, is a by-product of cracking operations, but it is evident that this supply will not be sufficient. Deep reforming will help, but recourse may also be had to special processes like polyforming and gas reversion, which can produce large volumes of butylene from naphtha and butane. Beyond that is the possibility of catalytically dehydrogenating normal butane into butylene. In general the job of the oil fields and refineries will be to revamp their equipment and processes to yield the largest possible supply of isobutane and their cracking operations to get the maximum amount of butylene.

In lubricating oils the principal problem is to obtain an adequate supply of extreme pressure lubricants for aviation and military diesel engines. Last but not necessarily least of the refining industry's tasks will be to supply sufficient toluene for TNT and butadiene for artificial rubber. As for toluene, there are special catalytic processes for reforming naphtha that give high yields of toluene, so this problem may be regarded as settled. For butadiene, this will have to be obtained from cracked products, or produced by thermal or catalytic dehydrogenation of butane or other stocks.

All the foregoing objectives, it is repeated, must be obtained in the shortest time and with the least use of steel and machine-hours.

PHYSICS

Determining the Viscosity of Oils Below Their Cold Points—O. Amsel and H. Stapel, in OEL UND KOHLE, vol. 36 (1940), No. 45, pp. 512-514.

In the design and operation of pipe lines it is of interest to forecast the behavior of the oils under various temperature conditions, especially at low temperatures near or below the cold point. The property most relied on for this information is the viscosity. However, when a paraffinic crude oil has been cooled to the point where it will contain suspended paraffin crystals its properties will not coincide with those of a Newtonian fluid to which the Hagen-Poiseuille law applies. The matter is likely to be confused by variations in the rate of cooling which determine the form of the separated paraffin crystals. Since laboratory determinations of viscosity give little dependable information in this region, it is logical to investigate flow rates under conditions approximating those of practical operations.

For determining the rate of flow under practical conditions the apparatus illustrated in the accompanying sketch was constructed. It consists of two sections of

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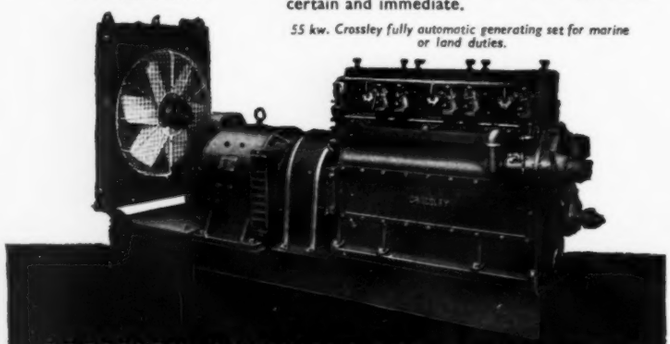

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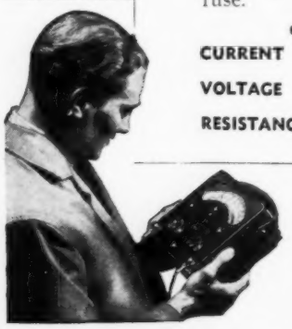

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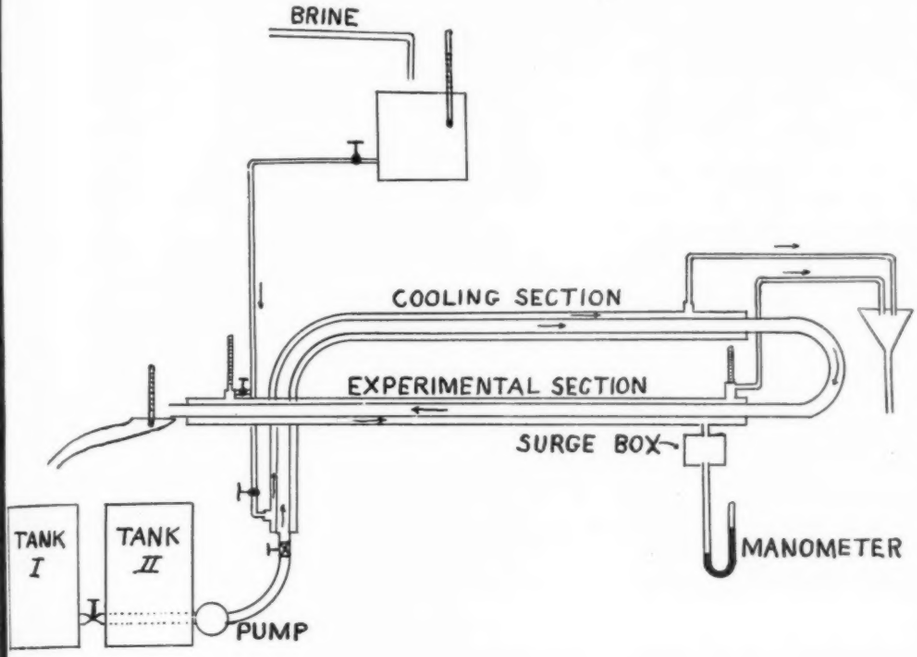
jacketed 1" pipe. In the cooling section the oil from one of the two measuring tanks is adjusted to a desired temperature by means of a brine which is circulated through the jacketed experimental section, this pipe through the jacketed experimental section, this pipe is 5½ meters long. The oil is taken alternately out of one of the measuring tanks by a constant-speed gear pump and returned to the other tank. The frictional resistance due to viscosity is measured by the manometer, from which the pressure loss in the system, the velocity of flow and the viscosity may be deduced.

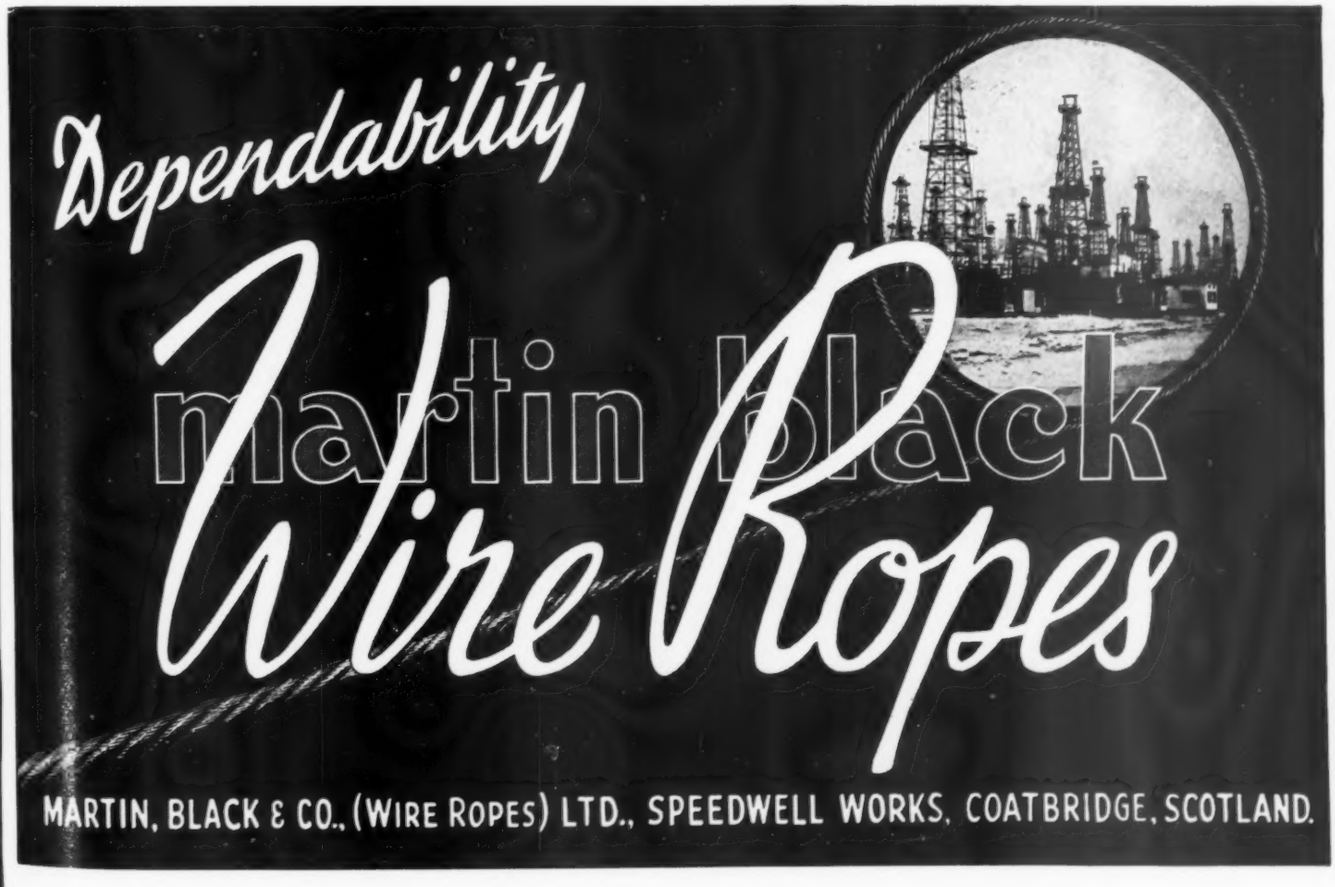


In the operation it was observed that after a while a layer of separated solid would accumulate on the inner wall of the experimental pipe and the indicated viscosity would mount. After a time this layer did not seem to increase in thickness. By emptying the system of fluid and melting the solid layer, the reduction of the effective diameter of the pipe could be calculated. When this reduced diameter was inserted in the Hagen-Poisseuille equation the viscosity as determined by this apparatus agreed with the conventional laboratory determination.

BOOKS

Practical Marine Diesel Engineering—by L. R. Ford, Published 1941, by SIMMONS BOARDMAN PUBLISHING CORP., New York; third edition, 590 pages; $5.00.

This book is devoted to a description of the makes of Diesel engines now most commonly found in the principal types of vessels. Particular attention given to the machinery arrangements of the U. S. Maritime Commission's standard motorships, the Diesel engines in them and the indirect drive systems adopted by the Commission. There is also a section for discussion of Diesel tugs and their machinery. Besides these engineering matters the book treats extensively on the operation of Diesel motorships, lubrication, etc., and the basic principles involved. The final chapter outlines the requirements for obtaining a license as a motorship engineer.



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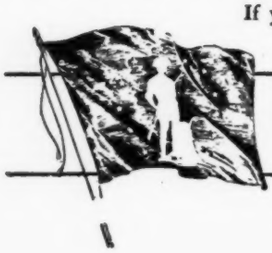

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